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ENGINEERING NEWS.

Civil Engineering Education.

BY J. A. L. WADDELL, M.S. E.

The subject of the proper education for civil engineers, important as it is, has never yet been systematically and adequately treated. Numerous papers, some of them of undoubted value, have appeared of late years in the technical periodicals of America, and quite lately the subject has been taken up in England; but none of the authors of these papers have attempted to cover the whole ground, or go at all into detail. For the last six years the author has been endeavoring to prepare a comparatively complete paper upon the subject, but has repeatedly failed, each time coming to the conclusion that his experience has not been sufficiently extended, and finally deciding that an entire lifetime devoted to the teaching and practice of engineering would not be enough to qualify one as an authority upon how all branches of the profession should be taught and learned.

As the field of civil engineering has within the last half century become greatly extended, it results that, if any one wish to rise to eminence in the profession, he has now to choose a specialty, and confine himself thereto. Even such a one at the end of a long lifetime will probably have to confess that he cannot consider himself thoroughly posted concerning everything connected with his specialty, and that there is and always will be a great deal to be learned.

Now as civil engineering is composed of specialties, it is evident that to be able to say exactly how any branch of the subject should be taught one should not only be a specialist in that branch, but also should have had some experience in teaching. Hence the conclusion is inevitable that, to do justice to the subject, it must be treated and discussed by a number of engineers and professors of engineering. With this object in view the author has prepared this paper, trusting that it receive proper discussion.

Although most of the branches of civil engineering are here dealt with, the writer wishes it to be distinctly understood that he has no intention to try to cover the entire ground even in one branch; and that, even if his opinions appear to be emphatically asserted, he is so far from being set therein that he hopes they may be considerably modified by the resulting discussions.

Any one who has given the matter any attention whatsoever must have come to the decision that the methods of instruction in technical schools have not kept pace with the great strides made of late years in engineering practice; and any one who has not heretofore given the subject special attention would be quickly convinced that such is the case, if he were to compare the curricula of the principal institutions where engineering is taught, as given in their catalogues of ten years ago, with those contained in the catalogues last issued. Moreover he would be confirmed in his conclusions if he were to spend a few weeks in examining some of these institutions and noting how the old methods of teaching are religiously adhered to, and how antiquated text books are still employed.

He would be impressed by the fact that what progress has been made is to be found not in the old schools of established reputation, but in the newer ones and even in some of those which do not make a specialty of engineering, or even of science, and which employ only one professor of civil engineering. In many of the latter, though, he would probably observe that decided progress has been made in only one department of the subject, the other departments being at a standstill or retrograding.

Such being the state of affairs, the question arises, 'What are the causes?

They are both numerous and varied. Among others are the following: a lack of money for the purchase of apparatus and for the adequate payment of instructors; bad directorship and the management of the institution upon narrow and short-sighted principles; the fossilization of professors, who, finding that after a year or two the routine of teaching is not very onerous, are content to take life easily and thus fall behind the times; the employment of incompetent and inexperienced instructors, partially from motives of economy and partially because of the common but mistaken idea that it takes more ability to practice engineering than to teach it; allowing or forcing a professor to teach too many and too different branches; a scarcity of proper text books; the neglect of the study of the *science of technical teaching*; the hampering of the faculty by trustees who are not engineers, and who are consequently entirely ignorant of what is requisite for the success of the course; the want of a good, ample and well kept library; the absence of harmony in the governing faculty; low standard for admission, so placed as to obtain a large number of students either to make the institution pay or to make it appear to be in a flourishing condition; the lowering of the graduation standard for the same purposes; the absence of a proper harmonizing of theory and practice, in some institutions the former being considered the great requisite, and in others the latter; the enforced spending of students' time in a useless manner; the introduction into the curriculum of subjects that are either not needed at all or that the students should be prepared upon before being allowed to enter the institution, and the entire neglect of subjects of the greatest importance; the omission of designing from the curriculum; the short time allowed for completing the course; the want of harmony between professors and students; and faulty and inadequate methods of examination.

Of all these reasons the most serious is undoubtedly the want of money, for it entails many of the others. To ensure success the income of any institution should be sufficient to pay all salaries, purchase apparatus, etc., and meet all running expenses without relying at all upon students' fees.

After a sufficiency of money, the next most important requirement for the success of an institution is good management. The real governing power may lie in the hands of a president, a director, or the faculty as a body or may be divided between any two or even al, three; although in most cases when the latter arrangement is supposed to hold, an investigation will show that the power of one or more of these parties is merely nominal.

Probably the best arrangement that could be made would be to intrust the business management of the institution to the director, making him responsible to the board of trustees, and to leave all matters relating to the curriculum to the faculty; by the latter term meaning the director, professors and assistant professors.

The method of investing the director with autocratic power is liable to work very badly; moreover it is incompatible with American principles.

It is no easy matter to find a man in every way suitable for a director, and who would be willing to accept the position. Among the principal requisites are tact, energy, integrity, ability and experience. His career, both professionally and otherwise, should be without flaw, and his bearing should be such as to command the confidence and respect of the faculty, the students and the general public.

He should not be required to teach, but should be capable of so doing in several of the departments; indeed it would not be a bad plan for him to take a class occasionally (of course with the consent of the professor) in order to judge of the progress which the students are making. That such men as the one described are to be found in the engineering profession, nobody is likely to deny; the difficulty would be to offer them sufficient inducements to forsake remunerative practice.

The next essential is the employment of thoroughly competent instructors; there should be no difficulty found in this matter if the salaries offered be large enough. A professor of the proper kind is not liable to fossilization, so when systems of the disease begin to appear, the most effectual remedy to apply is a change of climate: it will be found to work well both for the professor and for the

institution. Incompetent instructors and those who have lost their energy should not be retained from mistaken motives of sympathy, but in the case of a professor who has worked long and faithfully for the institution and who from declining health has lost the vigor necessary to give a thorough course of instruction, an ample pension should be voted him and he should be permanently retired.

If a professor has too many classes to attend to, and too many subjects of widely varying character to occupy his mind, he is liable to degenerate into a mere teaching machine; on the other hand if he has too little work allotted him, he is apt to become lazy and shirk his duties. If circumstances be favorable, it is well to have a large number of professors who are specialists in various branches, and to require them to work only a certain fixed time in each year. The salary of each one should be large enough to pay him more for the time spent in teaching than he would be apt to earn in the same time in practice. In this way there would be no inducement to neglect the course for the sake of outside work. It would be better, though, to require certain members of the faculty to devote their entire energies to the institution.

If circumstances be unfavorable for the above arrangement, the next best thing is to supplement the instruction in the various practical branches by lectures given by specialists.

If a state of harmony exist between the different members of the faculty, the methods of instruction can be greatly improved by friendly discussion at faculty meetings.

A complete library of the best and latest technical works is absolutely essential to a first-class technical school. The number of copies of each book in the library should be adjusted to the wants of the students; and it would not be a bad plan to arrange for students who are obtaining their education in spite of straightened circumstances, to have the use of text-books belonging to the library.

An arrangement should be made with certain booksellers by which a single copy of each new scientific or technical work would be sent to the library as soon as issued; and monthly notices of the receipt of such books should be distributed among the professors in order to determine the expediency of purchasing more copies or adopting said works as text books.

A large, attractive, well-stocked and well-kept reading room should be the adjunct of such a library. In it should be found all the scientific and technical periodicals in the English, French and German languages; and the number of copies of each periodical should be adjusted to the number and requirements of the readers.

Earnest students would freely patronize such a reading room and would be benefitted greatly thereby. Strict maintenance of order would be an essential element for its success.

The omission of designing from the curriculum of a technical course is one of the gravest errors that can be made. A single design in the whole course is not enough; there should be one in each of the courses in which it is practicable to have one. They should be made under the direct supervision of a thoroughly practical and competent instructor, and should be completed in the rooms of the institution. No design should be considered complete without a full, detailed estimate of cost, figured according to current prices. Most students, and possibly some professors, are apt to think that engineering and business are two entirely distinct affairs; it is only when they go out into practice that they will find what a grave mistake they have made. In designing, special stress should be laid upon the consideration of economy; for it is this particular which is characteristic of the American engineer, and which gives him the advantage when coming into competition with his European brethren.

That the line between theory and practice can never be accurately drawn, should be borne in mind by both instructors and students.

A man well posted in theory but not in practice may be an excellent mathematician but he is not an engineer; while on the other hand no man can be truly posted in practice who does not understand enough mathematics to establish or understand the establishment of most of the equations which he uses in his calculations. Those who have a penchant for long and complicated formulæ, rule of thumb men, and pocket-book engineers are seldom, if ever, capable of doing first-class engineering work, unless it be of a low order.

Ten years ago the want of proper text books was a serious impediment to both professors and students of engineering. To-day matters in this respect are somewhat improved, but a sufficiency of first-class, properly written, practical text books is still a desideratum. For the higher classes in an engineering course, books written especially for students are unnecessary, if not really objectionable. Such students should use books written for engineers; and if there be more than one good book on any particular subject, they should not confine themselves to one author; for by reading the works of many men one's views become broader, and one's knowledge more extended. Concerning this subject of engineering literature it is not necessary to say more here, for the author has lately written thereon in two papers published by engineering societies.

The time allowed for completing most technical courses is too short, and the most practical and useful courses are generally left till the last year. With a much higher and more extended entrance examination than is usual in technical schools, four years might be found sufficient for giving a pretty thorough course in civil engineering; but in the opinion of the author five years would be much better. It is not well to require, for entrance, preparation on very many important subjects; because students would be admitted who were not thoroughly grounded in the elementary studies. For instance, it would not be well to require analytic geometry and the calculus at the entrance examination; for these are seldom, if ever, properly taught outside of technical schools—nor, it is a pity to have to confess it, always thoroughly within them.

The more preparatory schools there are for technical institutions the better for technical education; and in case the faculty of an engineering course have perfect confidence in the instructors of a preparatory school, it is well to permit graduates of the latter to enter the former without passing an examination. Such a course of action would encourage young men to prepare themselves thoroughly in preliminary studies before entering technical schools.

A want of harmony between professors and students is one of the greatest drawbacks to the success of any educational institution. Students should look upon their professors as their best friends, who are doing their utmost to prepare the young men entrusted to their charge for their coming life struggle.

Although a high standard of scholarship in all departments is absolutely necessary to the success of any educational institution, this should cause no ill feeling between students and professors. The former should recognize the fact that if any one of their number cannot come up to the standard, he should be dropped; and that there is no other course open to the faculty.

Students who have failed to pass the examinations should not be allowed more than one chance to regain their lost position; such an arrangement tends to make students work regularly and systematically. In fact it might be better to allow no one a second examination, except in case of sickness. Conditioned students will always come under one of the following groups: 1st, those who are lacking in ability; 2d, those who from sickness or some similar cause have been prevented from attending to their classes and their work; and 3d, those who are wanting, not in ability but in application.

Sympathy on the part of the examiners for those of the first group is a great mistake. Those of the second group ought certainly to be allowed another chance; and a high standard with rigid rules will reduce the number in the third group to a minimum. Men of good ability but of chronic laziness, as far as the welfare of the class is concerned, are much better dropped than retained.

Much of the success or failure of a technical institution depends upon its methods of holding examinations. Of these there are many varieties in different institutions, and nearly all are faulty.

The English method, which passes or rejects a student almost solely on the result of his examination, is bad for two reasons: First, it encourages cramming and the employment of tutors who have no direct connection with the institution, thereby making the true value of a student's knowledge more apparent than real. Second, it places a man of a nervous temperament at a great disadvantage. Cases of students, who have proved during the course that they are well posted on the subject, failing from nervousness at examination are by no means uncommon. It is obviously unjust to make a man's passing in such a case depend wholly upon his examination.

On the other hand the method employed at certain American institutions is equally faulty. There the students are told a week beforehand what will be the black-board topics for examination, and are certain that during the oral examinations they will be asked no questions that have not been asked during the interrogations of the advance and review courses. This method for students in the highest branches of learning is a mere farce.

Some instructors prefer written and others oral examinations; but in the author's opinion, unless there be peculiar conditions which are not liable to occur in America, both methods should nearly always be employed. Written examinations are better where the work is principally mathematical; but there is no way to test a man's practical knowledge of a technical subject that can compare with the oral examination.

But there is more than one way of holding an oral examination. That of asking each student a few questions from the course, as given during advance and review, in the presence of a number of his classmates, is entirely inadequate. Each student should be interrogated privately in the presence of at least two examiners for from half an hour to an hour and a half, the time depending upon the manner in which he answers the questions.

The time at which examinations are to be held is an important consideration. The method of requiring a candidate for graduation to pass at the end of a four years' course a number of examinations upon all that he has studied during the four years is too hard upon the student, and tends to make his knowledge merely superficial. Half yearly examinations are much better. The method of letting a student come up to examination whenever he

feels prepared tends to upset the system of an institution, and causes the examiners unnecessary labor.

Written examinations should last four or five hours, and the number of questions to be answered in that time should be adjusted to the capacity of slow students; for it is not always the most rapid thinkers who achieve the greatest professional success.

In preparing examination papers on technical subjects such questions should be chosen as will indicate the practical and useful knowledge of the students, and not those which involve mathematical demonstrations, merely for the sake of the mathematics.

The question as to what should and what should not be taught in a course of civil engineering is one upon which there is a great variety of opinions. Some engineers say, "teach the student merely the elements of engineering and ground him well in mathematics, so that after graduating he can choose a specialty and devote himself to it." Others say "give him a good mathematical education and let him pick up practical methods afterwards; there are plenty of chances to get a good practical education at any time of life, but mathematics should be learned when young."

Others, on the contrary, say "what is the use of filling students' minds, with a lot of mathematical rubbish that they will forget just as soon as they go into practice? Give them a good, practical education and don't waste their time."

These views are extreme, and therefore to be avoided. It is true as before stated that now-a-days, when the field of civil engineering has become so large, it is necessary to success that one devote himself specially to one or two branches of the profession; but this is no reason why he should be practically ignorant of all the other branches.

The writer's method would be to instruct the student both theoretically and practically in every branch of the profession as much as possible, so that when he adopts a specialty he will know something about other branches, and be able to form an intelligent opinion about the works of others. Besides, in some departments of engineering, an engineer requires to be well posted in many branches of the profession; for instance, a city engineer has to be well informed in road-making, sewerage, water supply, surveying, architecture (at least elementarily) and earthwork, besides being also a good business man.

In the writer's opinion the course of instruction in pure mathematics for civil engineers should end with the calculus and least squares. One seldom, if ever, finds use for quaternions, elliptic functions, transcendentals, etc.; these should be left for professed mathematicians. But unless one has been thoroughly and intelligently drilled in arithmetic, algebra, geometry, trigonometry, analytic geometry, differential and integral calculus and least squares, he will sooner or later in his practice have cause to regret that his education in these studies was neglected.

The proper way to correct existing evils and deficiencies in American engineering courses is not to reduce the amount of theory, but to increase the amount of practice, and throw many of the elementary subjects taught, into the entrance examination. By the term "practice" is not meant, as is usually the case, merely surveying; but surveying, designing, estimating and shopwork.

Purely technical courses should be made no more mathematical than necessary, and all mathematics should be made as simple as possible. The old idea that the more one has to puzzle over intentionally knotty mathematical points the more will his mind be developed, is a fallacy. There are plenty of useful practical studies in these days that will give to one's mind all the development that can be desired. For the same reason if there be typographical errors or other mistakes in a book, they should be pointed out to a student before he uses it; for it is a mistaken idea that in discovering the errors he gains knowledge—on the contrary, he simply loses temper. There is nothing more exasperating than to work an hour or more trying to solve an equation, and finally ascertain that the book is wrong.

Students should not at the same time have on hand more than three or four courses. Too many studies confuse the mind and discourage a student; while a continued application to one subject is wearisome, so it is well to have one or two more to afford a little variety.

The general idea that, if possible, each course should be given out of but one text book is wrong, and is based upon nothing but a false economy. By confining one's reading on any subject to a single author one often sees only one side of the question, and it is seldom that a single book can cover the whole ground properly. On the other hand there are often portions of different books that are nearly identical; in such cases the instructor should see that the student does not waste time in going over the same ground twice; sometimes, however, by so doing he gains by impressing the matter upon his mind.

There is no doubt that there is such a thing as "the art of studying" and that any one who has mastered it can do much more work in a given time and do it better than one who has not. This is not a case of the development of the faculty of memory, though that too, when the faculty be not misapplied, is advantageous. By much practice, an exercise of the will, and a systematizing of methods, one can so train his mind as to grasp readily mathematical reasoning, see at a glance mathematical deductions and perform readily other difficult mental feats. In this respect the Japanese far excel Europeans and Americans. The amount of work that a Japanese science student gets through in a day would appall most of the men in American universities. Moreover they do it just as thoroughly as their American brethren, and without spending upon it any more time.

If a student of the higher classes in a technical school work faithfully from 8 A. M. till noon, and from one o'clock till half past three or four, also an hour in the evening, he ought to accomplish sufficient for one day, but under-classmen would require to work an hour or two more in the evening. There are two reasons for this: First, the under-classmen have more mathematics; and second, they have not had so much mental discipline as the upper-classmen. Much study at night is not good for the student's health; so for this reason, if for no other, they should be made to work during the day in the buildings of the institution. Students should be encouraged, but not compelled to read outside of working hours at least a few books not connected with the course; such works, for example, as those of Darwin, Huxley, Spencer and Tyndall and the periodicals *Nature* and the *Popular Science Monthly*. A little light literature occasionally will do no harm, for it will serve to give the mind a rest.

The practice of having no classes on Saturdays is not conducive to the accomplishment of a large amount of work. It ought to be a sufficient concession to popular notions to stop work on Saturdays at noon.

The vacations and holidays should be so arranged as to have nine solid working months in the year; this would give two hundred and fifteen days, which, at seven and a half hours per day, would make over sixteen hundred hours per year, to be passed either in the buildings of the institution or in the field.

There are two methods of instruction in general use in technical schools, viz., the lecture system and the recitation system; to these the writer would add a third and call it the consultation system.

The lecture system, although employed almost exclusively in England and Germany and to a great extent in the United States, is in the author's opinion by no means a good method of imparting instruction to science students. In the first place the ground which a lecturer can cover in a day is about one-third or one-fourth as great as a good student can cover in the same time by using text books. In the second place, one can in general remember much better what he has learned from a book than what he has heard at a lecture; because by the former method he can go slowly over the difficult parts and rapidly over the simple ones, while by the latter he is compelled to think just as fast as the lecturer talks and no faster. In the third place, lecture notes, besides being an imposition on the students, are a delusion and a snare, for they are very seldom correctly taken even when copied from the black board.

Is it not much better and more economical of both the professor's and the students' time to have the notes printed in book or pamphlet form? In such cases the excuse is sometimes made that the professor has an objection to appearing in print, or that by publishing the notes he would be giving away the secrets of the trade.

In engineering there should be no such thing as a "secret of the trade;" every true engineer is always ready and glad to let others benefit by his experience; and anyone who fears to put his teachings into print is not fit to be a professor.

There are but three cases in which lectures, other than experimental ones, may be advantageously given; first, one at the opening of a course; second, another at the end of the same; and third, when the information to be given cannot be found in any text books.

The recitation system is much more satisfactory than the lecture system; but it, too, has its disadvantages. It is undoubtedly very thorough and consequently well adapted for the lower classes, the students of which are not as yet well broken into proper methods of study, but for upper classmen it savors too much of the boys'-school. Moreover, it tends to make students strive for appearance rather than reality, and encourages them to be dishonest.

Another disadvantage is that it tends to prevent students from asking the instructor questions connected with their work; for they fear that by their so doing he will acquire a poor opinion of their capabilities, and will give them low marks in consequence.

The recitation system in spite of its disadvantages is by far the best for the courses in pure mathematics and rational mechanics. When students are unwilling to work, it can also be used advantageously in technical mechanics.

(TO BE CONTINUED.)

South African Railroads.—The line from Worcester to Robertson is nearly completed, and will be pushed on to Swellenham and ultimately to the Midland system; the rails and bridges are brought from Antwerp. The new pattern "Crampton" locomotive, tested at Leeds and Woolwich, seems suitable for the heavy grade line to Maritzburg, on which non-paying loads are hauled by eight-coupled engines. Beyond the city the grades to Ladismith (180 miles) are easier and the track stronger. Locomotives are run on the Namaqualand R. R., 30 inches gauge, from Port Nolloth to Kiep. A steam or electric street railroad is projected to connect Kimberley, Barkly, Dutoitspan and Bultfontein. The Natal R. R. is overcrowded with traffic, but the ruling load to Maritzburg is only 40 tons, so it is proposed to order a couple of "Fairlie" locomotives, which could haul about 80 tons. Two steam street railroads are under construction to Barkerton.

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

(*Continued from page 418.*)

Official Plans.

On account of its extensive area and the irregular surface of a great portion an accurate topographical survey of the whole city is a great work and has not yet covered all the rural districts. The preliminary mapping, on a scale of 100 feet to the inch, with contours every 5 feet, is done by the district surveyors as directed by councils, usually in sections of about 300 acres. Streets are located on these maps by the surveyors (individually), on the rectangular system, generally parallel to and at right angles to existing property lines, and at such distances apart as seems sufficient for the probable needs of that locality (generally about 500 feet) and 60 feet in width, names given them and grades established—all subject to the approval of the Board of Surveyors after visiting the locality.

Elevations are given on the map at every

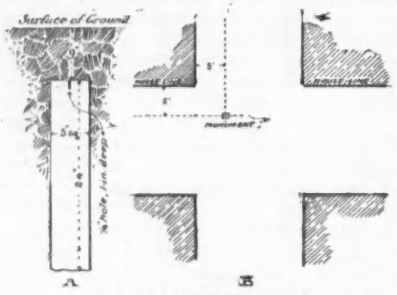

Plate 2½. Street Monuments.

street intersection and monuments set at the crossing of 5 feet ranges, as shown in Plate 2½. These are of white marble, 5 inches square and 24 inches deep, with a quarter-inch hole drilled to a depth of 1 inch in the center of the end, to be placed end up. They are planted 8 or 9 inches under the surface, and in rural portions are also used as level benches.

Three hundred and eleven of these sectional maps are already completed and on file in the office of the Chief Engineer and Surveyor. They are rolled and enclosed in tin tubs, placed in horizontal square compartments. The number of each is painted in plain black figures on white ground on the outer end. A handy index to them, consists of a small map of the city, mounted on heavy card-board, and having the sections corresponding to each of the large maps marked out by heavy colored lines, and the map numbers painted conspicuously on them.

A duplicate copy of each of these maps is retained in the office of the District Surveyor, who made it.

The plans of all city railroads, showing the location in street and the profile (filed by the company before constructing the road) are preserved in the same manner, and being in adjacent compartments (to the sectional maps), have their numbers painted in red figures on the end of the cases to distinguish them.

In addition to the above there is a street map of the city, to be completed in sixty sections, of which lithographed copies are supplied to all the engineering departments—highway, water, gas and electrical—for use as skeleton plans on which to plot their own work. They are half the scale of the sectional maps above described, or 200 feet to the inch, and are printed on heavy paper in sheets measuring 38 by 60 inches.

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The copy in use in the Department of Surveys has plotted on it the outlines of the drainage areas and the sewers already constructed—the size of the sewers being indicated by Roman numerals on the line, thus; —— IV —— (indicating a 4-foot circular sewer) or —— EIV —— (indicating an egg-shaped sewer 4 feet in height.) The elevation of the bottom of the sewer is indicated by plain figures at every street corner. They are filed flat in shallow drawers under the drafting tables, (see Plate 1) each sheet having its number on the lower right-hand corner, and also the number of its compartment or drawer.

On account of the expense of these lithographed plans, especially when changes are required to be made, they will hereafter be duplicated by some cheaper process, as the blue on white, and buildings will hereafter be shown.

Comp't.	No.		Date.	Index letter.	Remarks.
138	1691	Profile from Broad street, along Clearfield street to 5th street, thence diagonally to Lippencott street, along same to Leamy to Indiana to Rosehill street	1885	*c, l, l, i.*	(This and the preceding column occupy the whole of the right-hand page.)
435	1694	Map of Baltimore & Philadelphia R. R. from Cobb creek to Chester branch of Reading R. R., filed in Depart. of Surveys according to Sect. 2 of ordinance of city councils, approved July 3, 1885	1885 Aug. 24,	*b.*	
			Left-hand page.	Right	hand page.

Plate 3.—From Record Book of Plans in Office of Chief Engineer and Surveyor.

It is also designed to indicate water and gas pipe on the copy in the chief engineer and surveyor's office.

Other plans and drawings are also filed flat in shallow drawers, except very long sheets, as profiles, which are kept in tin tubes, numbered on the ends like the sectional maps first referred to. Whatman's antiquarian drawing paper, either in whole or half sheets is the size mostly used. The drawers and compartments are of different sizes and shapes to accommodate different sizes and kinds of drawings. Small plans most frequently referred to are kept in one case of pigeon holes having a sub-index on the inside of the door.

A record of all maps and plans in the office is kept in the form shown in Plate 3. (The examples are taken from the last page of entries in September, 1886, showing the number of plans then on file). They are indorsed in the form shown in Plate 4, (the same examples being selected.) All indexing of plans made by the department is by names of streets, as that of the profile in example, which is indexed (as indicated in the record book) under Lippincott, Leamy and Indiana as well as Clearfield; and plans from without (as the other example) are indexed by the most prominent word. The narrow columns on the left of the page are for the second letter of the index word—that letter being placed in its own column and a mark made at the top. Thus, in looking up Clearfield, one would turn to that part of the book containing the *Cs*, (as indicated by the common projecting leather tag with the letter stamped on it); would run his eye along the top of the row of second letter columns—perhaps over many pages—until he came to an × above the *l* column; then would run his eye down the page until Clearfied appeared. The number of pages to allow each first and second letter in making up the index is determined by the number of streets beginning with those letters and their importance in the Department of Surveys.

Standard of Measurement.

The standard of length used by the Department of Surveys is the 10-foot steel furnished by the U. S. Coast Survey. A test line of 100 feet laid out with this measure in a corridor of the public buildings (on an asphalt floor over brick arches between iron girders,) has shown no appreciable change in five years.

Level Datum.

The assumed base of vertical measurements is an arbitrary plane (once supposed to be that of maximum high tide in the Delaware river, opposite the city). It is 8.732 feet above the mean surface of the Atlantic ocean at Raritan Bay.

Sewerage.

Owing to the great age of the city and to the fact that its suburbs were under entirely different management, with apparently no efforts towards a combined and harmonious system of drainage, until their population grew to be more than twice that of the city proper; also to the subsequent incompetent administration and division of responsibility—the main sewers being constructed under direction of the Chief Engineer and Surveyor, while (until recently) the branch sewers were built by the Chief Commissioner of Highways who also still has charge of the maintenance of all sewers—backed by a surprising indifference of the people to the condition of this branch of municipal government;—owing to these things, the public drainage of Philadelphia became notoriously defective and the old portion still remains so. Therefore however excellent the administration at present or henceforth, it will require many years and the expenditure of enormous sums to secure good sewerage for the city.

The public drainage of the city is at present entirely on the combined system, though it is proposed to introduce the separate system in Manayunk, a manufacturing suburb, (the Twenty-first Ward and the northwestern portion of the Twenty-second,) now draining into the water supply as soon as the intercepting sewer now constructing is completed.

On January 1, 1885, there were 53 miles of

×												×														Title or Description.	Date.	Comp't.	No.
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*				
B	a	l	t.	&	Ph	i	l	a	R	R		M	a	p												from Cobb creek to Chester branch of Reading R. R. filed in Dept. Surveys, according to Sec. 2 of ordinance of City Councils approved July 3, 1885	1885 Aug. 24,	435	1694
C	l	e	a	r	fi	e	l	d		S	t.															profile from Broad street to 5th street, then diagonally to Lippencott street, along same to Leamy, to Indiana, to Rosehill street	1885	138	1691

NOTE:—On the original the light lines are *blue* and the dark lines, *red*.

Plate 4.—Index to Plans in Office of City Engineer and Surveyor.

main sewers and 192 miles of branch sewers. Previous to June 21, 1882, all sewers were circular in cross section. Since that date branch sewers, excepting pipe, equal in capacity to a 3-foot circular sewer and under, are egg-shaped, while all others remain circular.

Plate 5 shows cross sections of the two types, the egg-shaped branch being a type of the maximum section on artificial foundation, and

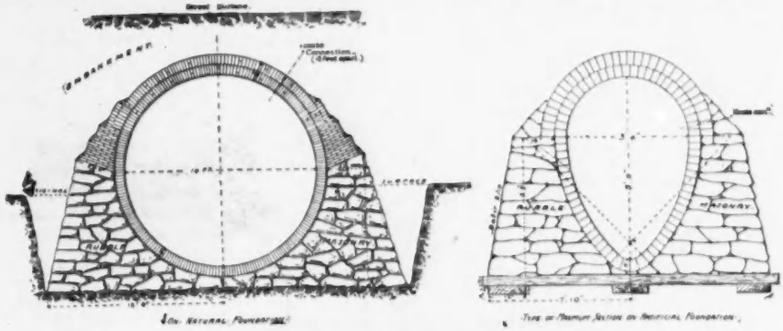


Plate 5.—Standard Types of Sewers.

the circular main, also a maximum section, partially below the original surface. No special explanation of the drawings is necessary. House connections (6 inch., 15 ft. apart) are inserted on each side, about 45° above the springing line and at an angle of 45° with the sewage current. The materials are (in general) straight, hard brick, in American cement tested to bear a tensile strain of 30 pounds per square inch in twenty-four hours. Portland cement is used in all important places, as inlets, wells and junctions.

For very flat grades (giving a velocity ap-

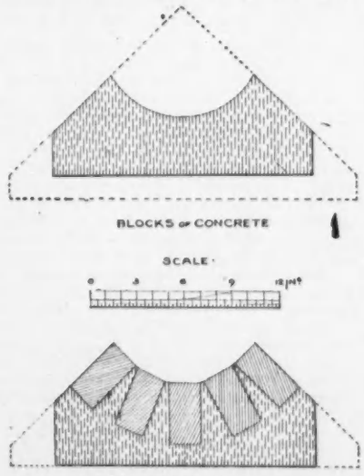


Plate 6.—Concrete and Brick Bottoms.

proaching the minimum of 3 ft. per sec. when running full,) and in medium soft or wet ground, concrete, or concrete and brick bottoms are made, as shown in Plate 6. For high velocities (approaching 10 ft. per sec.) stone (granite or hard-trap) invert blocks are used.

TO BE CONTINUED.

IT is said that a material called cork stone is extensively used for building purposes in Germany and Belgium. Patents were secured for its manufacture in 1880. It is claimed for it that it is a non-conductor of heat, cold and sound. The base of this material consists of pieces of waste cork, such as in many trades are thrown out unfit for use. These pieces, cut down to about the size of a pea, are mixed with a cement, consisting of mortar and clay, until each single particle is thoroughly coated with the cement, after which they are pressed into the proper shape and dried. From this manipulation results a porous body, resembling in appearance the so-called Rhenish alluvial stone, but of much less specific weight, that of the cork brick amounting at most to 0.30 or 0.35.

On the Wire Rope-ways between Vajda-Hunyad and Vadudobri (Transylvania)*

BY MESSRS. BOCHART AND LEBRETON.

The transport of material from Vadudobri, whence is obtained the charcoal used in the furnaces, and Gyalar, the center of the ironstone mines, to the Hungarian State Iron Works at Vajda-Hunyad, presents some special difficulties. The construction of even a narrow-gauge railway would have involved enormous expense, owing to the difficult nature of the country to be traversed, while the only road, and that a very bad one, has to make a detour of 30 kilometres (18¾ miles) to accomplish a distance of 10 kilometres (6¼ miles) as the crow flies. It was, therefore, necessary to adopt a special system of cable-transport which, in consequence of the difficult nature of the problem, presents several points of peculiar interest.

As a simple system on the Hodgson plan, in which a single traveling-rope serves both to carry and to transport the loads, was out of the question, owing to the gradients, which average about 1 in 30, and in special places are as severe as 1 in 7 or 1 in 8, it was necessary to adopt a pair of parallel carrying-cables for the up and down lines, each served by a hauling-rope placed at a lower level, but in the same vertical plane.

The local variations in the gradients and in the quantities of material to be transported, the enormous strain on the hauling-rope that would have been required to work the whole distance of nearly 31 kilometres (19 miles) in a single length, and the impossibility of maintaining such a length of carrying-cables sufficiently rigid, necessitated a subdivision into sections, as shown in the annexed table; the length of each station section, and the height of each above Vajda-Hunyad being given in metres. From Vadudobri to Gruniuli, the line ascends, but from Gruniuli to Vajda-Hunyad, the descent is continuous.

Section.	Height in metres above Vajda-Hunyad.	Names of Stations.	Length of Section in Metres.	Average Gradient.
1	797	Vadudobri to *Gruniuli*	2,424	1 in 25
2	892	*Gruniuli* " Plaiuli	4,418	1 " 45
3	798	Plaiuli " *Bunila*	4,277	1 " 53
4	713	*Bunila* " Pojinitza	4 291	1 " 64
5	646	Pojinitza " *Ruda*	1,882	1 " 67
6	618	*Ruda* " Gyalar	3 603	1 " 18
7	416	Gyalar " *Catsenas*	5,347	1 " 24
8	192	*Catsenas* " Vajda-Hunyad	4,320	1 " 23
		Total	30,542	

The motive-power stations are distinguished by italics, the others being merely shunting or transfer stations. Each hauling engine works two sections of road, except at Catsenas, where it was found preferable to have two engines and two boilers. The total motive-power at the four stations is 35 H. P. Between Vadudobri and Gyalar only charcoal, and in some cases water for the boilers, has to be transported; but both charcoal and ironstone are carried between Gyalar and Vajda-Hunyad. It will be noticed that the most important stations—Vadudobri, Gyalar and Vajda Hunyad—are not encumbered with engines or hualing machinery.

On section 7 there is a single span of 470 metres (514 yards), with a gradient of 1 in 6½; on section 8, a single span of 420 metres (356 yards), with a gradient of 1 in 11½; and on section 5, two single spans of 205 metres (224 yards), and 333 metres (364 yards) respectively. In such cases three, and even four, supporting frames for the cables are placed close together side by side; but, elsewhere, where the spans are much shorter, they are placed singly. These supporting frames consist of two upright posts of oak or hornbeam, which are cheaply procured on the spot, united by two cross-beams, from the upper one of which is suspended a frame provided with two small pulleys, on which the carrying cables rest, while the lower one carries two rollers for the hauling ropes. The height, and the size of the timbers, vary considerably according to circumstances; but they may easily be carried up so, say 23 feet, two or more raking struts being added where necessary.

The carrying cables—of steel, 1 inch diameter—are heavily loaded at each end with weights proportionate to the lengths, gradients, spans, and loads to be carried, which, as has been seen, vary considerably in different sections, and are supported on small rollers so as to be free to move under the influences of expansion, contraction and deflection under varying loads.

The hauling is effected by a single endless steel rope (of ¾-in. diameter) for each section, serving both up and down lines. At the driving end it passes round a horizontal grooved pulley, 2 metres (6 ft. 6¾in.) diameter (corresponding to the distance apart of the ropes) driven by the engine, and at the other end round a pulley of similar size mounted on a sliding frame weighted with a heavy counterpoise for keeping the rope taut. On it, at regular distances of 134 metres (147 yards) on the sections between Vadudobri and Gyalar, and of 54 metres (59 yards) on the sections between Gyalar and Vajda-Hunyad, where the traffic is the heaviest, are fixed small steel clips, which are gripped by an ingenious apparatus attached to each tub, an automatic releasing arrangement being provided at the end of each section of line, where the tubs are guided off the carrying-cables on to fixed rails of peculiar construction, until they are transferred to the next section, and gripped on to the hauling rope by the man in charge at each station. Wooden carrying rollers are provided for the hauling ropes when not in use, or when they sag to any considerable extent; but when in action they are supported by the tubs themselves.

The tubs, which are carried on trunnions so as to be easily tipped, are of bucket form, suspended from two grooved wheels traveling on the carrying-cables by a frame which also carries the gripping apparatus above referred to. An empty tub weighs about 4 cwt., and will contain about 6 cwt. of ironstone, or about 2 cwt. (say 14 bushels) of charcoal. There are, at one time, 240 tubs of ironstone, and 434 tubs of charcoal (including returning empties) in circulation, traveling at about 2¾ miles per hour, and capable of delivering about 160 tons of ironstone, and 4,400 bushels of charcoal per day of ten hours.

*Proceedings Institution of Civil Engineers.

It is not easy to estimate the cost of transport with any great accuracy, as the system has only been in operation for a very short period, and the data obtainable are incomplete but it probably averages about 0.89 and 0.92 francs per ton per kilometre (1*s.* 1¾*d.* and 1*s.* 2¼*d.* per ton per mile) for ironstone and charcoal respectively, due allowance being made for depreciation and interest on capital. This is about one-half the cost of transport in bullock carts.

The paper is illustrated by engravings showing sections of the line, and details of the carrying frames, tubs, gripping apparatus, and hauling and shunting stations.

A Hydraulic Gravel Elevator.

In the accompanying design the principle of the injector is applied on an extensive scale to the elevation of auriferous gravel into a flume from bed-rock workings.

It is to be used in connection with sluicing or hydraulic mining and requires an abundant volume and head of water for its proper action. But it comes into play when ordinary methods cease to be profitable or even feasible; that is when gold bearing deposits are found in basins or low lands adjoining creeks. It is then intended to do away with laborious and expensive use of barrows and shovels, and pumps, etc., for clearing these low spots of water.

The principle of the jet application needs no further description, and the drawings explain the manner of its manipulation which is simple enough. All that is required is sufficient power in the water supply to overcome the elevation to which the gravel and earth is to be projected. In regard to the volume of water and head demanded by certain conditions, we have the statement that in the Yreka Creek Gold mine, in Siskiyou Co. Cal., with an elevator with a 16 in. discharge pipe to flume

Fig. 2.—General Application.

operating through about three years, it has been found that a volume of 650 miner's inches of water under a pressure of 266 feet was sufficient to supply two hydraulic "giants" for bank washing and to enable the elevator to lift the sluiced material through a vertical height of 47 feet into the flume; the piping action was continuous and at no time was the machine overloaded, The wear is said to have been inconsiderable.

The elevator as made has 12, 16 and 20-inch pipes to the flume. In practice, a pit or shaft is first dug from the surface of the gravel to the bed rock, of any necessary dimensions, and then sunk further into this rock, at least 5 feet. Into this the elevator is then placed as shown and the sluiced material led into the pit to be piped up by the water-jet into the flume or line of sluice-boxes.

This elevator is the invention of Mr. Joshua Hendy, manufacturer of hydraulic mining machinery, of 39-51 Fremont street, San Francisco, Cal. The device is in successful operation at the property of the Yreka Creek Company mentioned, and a 20-inch elevator is at work at the Miocene placer ground near Oroville, Butte Co. Cal., others are in use at different localities on the Pacific Coast, and near Atlantic City, Fremont Co., Wyoming, and at Golden, Colorado,

One of the latest and most interesting of its applications is at the hydraulic mining property of the North Bloomfield Gold Mining Co. of Nevada Co. Cal. Here by the late decisions of the California courts under the "debris act," a magnificent plant was rendered useless and an enterprise of twenty years standing was virtually stopped by the impossibility of disposing of the refuse from the washing without blocking up the streams. The Joshua Hendy Company now propose by the use of their elevators to impound the refuse gravel in the washed out workings and only allow the clear water to escape to the stream, and are now putting in the plant. If this is as successful as they predict, hydraulic mining can be resumed without detriment to outside parties and a now overshadowing source of trouble and litigation will be removed,

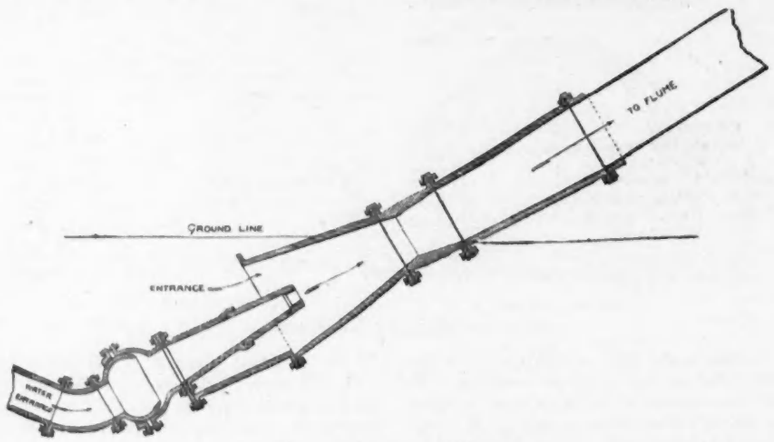


Fig. 1.—Hydraulic Elevator: Section.

On The Remarkable Effects of Adding Saccharine Matter to Mortars.

BY SAMUEL CROMPTON.

A letter from Mr. Thomson Hankey "On a New Use of Sugar"—*Times*, October 13—has given rise to wide discussion and inquiry. At a time when the price of sugar is so low, and, as I shall show, when the use of a very small quantity of it, or of treacle, adds largely to the strength of mortar, and makes Portland cement itself set with great rapidity, it seems to me that I may do a service to engineers by laying before them the scientific grounds on which I was led to experiment on the subject, and the remarkable results which have been obtained.

The practical importance of this addition of saccharine matter to mortar I will state briefly to begin with, and will give a few illustrations:

I mixed in a small jar some Portland cement and brown sugar, adding water and stirring. I took out a little of the cement for an experiment, and when I tried an hour after to take out more, I found that the remainder had already set.

My neighbor, Mr. Rowland, weighed carefully Portland cement and sand into four small jars. To two he added different sugars, to the third treacle, but to the fourth no saccharine matter. On the following day the cement had set—we do not know how much earlier, for it was not examined—in all the jars with saccharine matter. Mr. Holden, jun. the foreman of a builder, examined all of them on the Monday following the Friday on which they had been mixed. On pressing the cement to which the treacle had been added, he said, "I might press the bottom of the jar out before I can make impression on this." He then put his finger into the jar in which there was no saccharine matter, and stirred up the cement which had not set at all, and which did not set till a day or two after. It may be objected that it might not be an advantage that it should set so quickly. This objection will be answered by-and-bye as I proceed, by showing that it is highly probable that the strength of Portland cement will be greatly increased by this addition of saccharine matter.

Mr. Thomas Hankey had experiments made, first by his own brickmaker and secondly by a house builder. Both reported that the addition of sugar made a common lime equal to Portland cement.

The bearing of these facts will be plain to every engineer, but I cannot forbear mentioning here a startling incident. The Ecclesiastical Commissioners built for the late Bishop Fraser, of Manchester, on his coming into the diocese, a lodge like that at Lambeth, with a lofty archway set in Portland cement. A clerk of the works appointed by the architect of the Commissioners superintended it. After a due time the scaffolding was removed. One day—perhaps that day—the bishop walked through and had just got beyond danger, when the whole of the archway fell. If he had been under it, he would have been killed, and his grand career as a bishop would have been cut short at the outset. Your readers, as I proceed with my statement, will judge for themselves whether the addition of a few shillings-worth of treacle would not have made all secure, and have saved the expense of doing this work over again.

I have to explain how it is that sugar, or rather saccharine matter of any kind, produces this remarkable effect on lime. Here I ought to mention that I am a retired physician, and that the idea of putting the matter to the proof arose in the following manner. In medicine we have two kinds of limewater: one, the common lime water that can be got by mixing lime and water. It is to be particularly noted that, add as much lime as you like, it is impossible to get water to dissolve more than half a grain of lime in one ounce, or about two small tablespoonfuls, of water. But by adding two parts of white sugar to one part of lime, we obtain a solution containing about 14⅓ times more lime in the same quantity of water. Here it is to be observed—and it is a most important point—that there are hot limes, such as Buxton lime, which, if the sugar be incautiously mixed with them, will *burn* the sugar, make it a deep brown color, and convert it into other chemical forms, and possibly, and I think probably, will destroy its value in mortar. The way to use sugar with such limes is to dissolve it first in the water. I dwell particularly upon this, because a gentleman referred to me by Mr. Thomson Hankey, in writing to thank me for the information I had given him, casually observed that his cement had turned nearly black by the addition of the sugar. Probably many other experimenters with sugar and hot limes have had the same result, and are in the belief that all is right. Our strong medical saccharated lime water looks like water.

Ten or fifteen years ago I had been experimenting with lime and sugar, but not in reference to mortar, and I spoke about that time to my friend, the late E. W. Binney, F. R. S., about this property of sugar. He said that it was very curious, and that it was new to him; and he told me his anecdote, that in his grandfather's time an Italian architect came down to Worksop to erect a building for a nobleman, and insisted on being supplied with malt to make his mortar with; the malt was supplied and used. Many years afterwards, this building had to be taken down; but, said Binney, "they could not pull it down, do what they would, and they had to use gunpowder." I said, it would be the saccharine matter in the malt that produced this result. He agreed with me.

A few months ago I was at Peterborough, and went to see the progress of the restoration of the cathedral where I made the acquaintance of Mr. Irvine. Mr. Pearsons's clerk of the works. Mr. Irvine was for more than a quarter of a century with Sir Gilbert Scott, and possesses a greater knowledge of architecture, and antiquity bearing on English architecture, than anyone I

ever met with. One day I said to him that I had been to Fotheringay. He replied that he had seen every other church than that in the neighborhood of Peterborough. I asked him to go with me on his Saturday's half-holiday, as my visit to the church had been a hurried one, and I wished to make some further inquiries. Besides, I was glad to have the companionship of one who was so thorough a master of the subject. The chancel of this fine church, built before the nave, and so late as 1410, has entirely perished; and it had been so badly built that even in the time of Queen Elizabeth it had fallen in and was then in ruins. The chancel and tower exist, but the tower is unsafe, and if the church be not soon restored this grand historical monument may suffer or be destroyed. As Mr. Irvine and I walked to the railway station, I asked him whether he was aware of the chemical fact that the addition of sugar to water makes it take up about sixteen times more lime than water by itself does—I might have said a little more than fourteen times. He replied that he did not know this fact, and that he had never heard of it, and that he did not believe that it had been so used in mortars. I then told him what Mr. Binney had told me regarding the building erected by the Italian architect near Worksop. He said that he had been clerk of the works in the restoration of several cathedrals, in the books of which he had met with old entries of payments "For beer for the masons," and that he had found one entry where it was written, "For beer to mix with the mortar." I said that that would be for the saccharine matter in it; and, I added, that a few years ago I had seen in a newspaper that the vintage in Spain had been so abundant that the people had not casks enough, and were using the wine to mix with their mortar. It flashed across my mind that this traditional use of saccharine matter was probably the explanation of the exceptional hardness of the old Roman mortar, and had been handed down from generation to generation, and had at length been forgotten, in England at any rate. A few days afterwards I was pondering as I walked along the street in Peterborough on this matter, when suddenly I said to myself, "Why not try the experiment? I went into a grocer's shop and bought a pound of exceedingly finely powdered loaf sugar and some beeswax—of the wax I will speak some other time. I took the sugar to the hut in the cathedral yard, where I found the foreman of the contractor and Mr. Irvine. Laughing, I said, "I have come to teach you to suck eggs." After explaining to the intelligent foreman my views, he and Mr. Irvine kindly agreed to try the experiment. Some powdered lias lime and some of the sugar were being mixed together in an iron basin. Water was added, and Mr. Irvine began to stir them with a trowel. No sooner had he done so than he exclaimed, "Look, look! It is beginning to set already." I said, "Is not that usual?" He replied, "No; something very uncommon." The mortar was poured out on the end of a beam, where it set. Some more was then made much thinner, and a little sand added to it. With this, which was about the consistency of cream, two largish fragments of the broken stone tracery of an old window were joined, and so were two bricks, two pieces of glass, and two slates. It would be about five o'clock in the evening. As I was going to leave Peterborough about noon on the following day, I called at the cathedral about ten in the morning to see the results. Mr. Irvine said it was too early to judge. He felt at the stone tracery very tenderly. Holding the upper fragment, he then tilted the tracery sideways, and as the stones held together, he then took hold of the upper fragment with both hands and lifted the whole stone without the lower fragment falling off. In like manner, in lifting both bricks the lower brick did not fall off. The slate and the glass seemed also set. So that the experiments seemed to confirm remarkably the view I had formed, on theoretical and chemical grounds chiefly, that saccharine matter added to mortar would be of great value, and that an important discovery had been made. I wrote to my brother-in-law, Mr. Guildford Molesworth, engineer-in-chief to the State Railways in India, and author of "The Engineer's Pocket Book," telling him what we had done. From him I received a letter dated Simla, August 28th, 1886, giving me the following interesting particulars:— "With regard to your addition of sugar to mortar, it is a practice that has been in use in the Madras Presidency from time immemorial." The following is an extract from the Roorha (?) "Treatise on Civil Engineering," vol. i., page 150, third edition: "It is common in this country to mix a small quantity of the coarsest sugar—'goor,, or 'jaghery,' as it is termed in India—with the water used for working up mortar. Where fat limes alone can be procured, their bad qualities may in some degree be corrected by it, as its influence is very great in the first solidification of mortar. Captain Smith attributes the fact that mortars made of shell lime have stood the action of the weather for centuries, to this mixture of jaghery in their composition. He made experiments on bricks joined together by mortar consisting of one part of common shell lime to 1½ of sand. One pound of jaghery was mixed with each gallon of water with which the mortar was mixed. The bricks were left for thirteen hours, and after that time the average breaking weight of the joints in twenty trials was 6½ pounds per square inch. In twenty-one specimens joined with the same mortar, but without jaghery, the breaking weight was 4½ pound per square inch.

Mr. Molesworth then adds: "The use of sugar or jaghery was known to me when I was in Ceylon twenty years ago. The masons who came over from Madras used to make most beautiful plaster work, almost like enamelled tiles, of shell lime mixed with jaghery. The surface took a fine polish, and was as hard as marble; but it required a good deal of patient manipulation well suited to the national character."

This intelligence from India supplies proof of the most positive kind of the enormous strengthening power of sugar when mixed with mortar. It may be argued that some of our limes and cements are of themselves good enough without it. It is for engineers to judge whether they might not be made much better by it, or whether the facts I have brought forward do not show plainly that there should be an inquiry instituted by scientific men to investigate the actual *numerical* value of sugar, and the various conditions under which it acts, whether for better or worse. For the worse it cannot act, except such an insane use of it be made by adding too much, as to expect sugar to be itself mortar. The jaghery sugar used in India is sold in the London market at, I think, less than a penny a pound, and is used for feeding cattle. Treacle seems to me to be a most promising form of saccharine matter. I would shirk beet-root sugar. There is a rough unrefined treacle which is very cheap, and I should suppose would be excellent. A halfpenny-worth of treacle and water added to a hod of mortar would, I conjecture, increase its strength by one-third, if not by one-half. But I must leave the matter in the hands of scientific engineers. I think it is very probable that this use of sugar with lime is of extreme antiquity and that a knowledge of it passed from India to Egypt and Rome; and that these nations used malt for its saccharine matter as a substitute for sugar. I have shown that the mediæval builders used beer in building our cathedrals, and beer is still used with plaster of Paris. These I take to be the remnants of ancient tradition. It is said that in the co'd winter when Bess of Hardwicke died, her masons had to "melt the beer which they mixed with their mortar." They would have acted more wisely if they had used infusion of malt only, for most of the sugar must have been converted into alcohol, and lost for the purposes of mortar-making. Antiquarians may be able, from old documents, to throw light upon this subject: but I strongly suspect that the old Roman mortar had saccharine matter added to it; and I am of opinion that, in all engineering works requiring great strength, it would be wrong not to take advantage of facts confirmed by the experience of ages.

Cranley Surrey, November 30th, 1886.

The Engineer.

A Self-reading Rod for Levelling and Stadia Work.

BY GEO. J. SPECHT, C. E., SAN FRANCISCO, CAL.

ENGINEERING NEWS of November 13, 1886, contains the illustrations and description of several self-reading rods.

Some of the rods illustrated, are practical for work at any long distance, or for rapid and at the same time accurate work.

The "Francis" rod (Fig. 6, page 306) seems to be more impracticable than the others, as the closely set figures, vertical and horizontal, will be confusing at long distances and at times when the air is the least vibrating, caused by high temperature.

The "British" rod (Fig. 7, p. 306) is the nearest approach to a self-reading rod useful for long distances, the only fault it has is that the numbers indicating feet are too small.

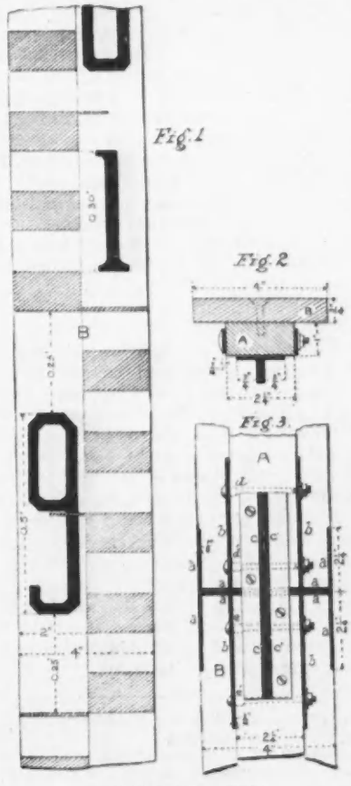
The "Texas" rod (Fig. 8, p. 306) is decidedly objectionable on account of its triangular division. The experience of engineers with large practice in levelling is that the subdivision by eye of an inclined line is much more difficult than that of a vertical line.

The rod shown in Fig. 5, p. 306 is of no use for long distances. The self-reading rod, illustrated and described in this paper is my invention—not patented,—and is superior to any one of which I have any knowledge.

Fig. 1. Shows the division of the rod; each foot is divided into tenths of a foot. The divisions occupy only one-half of the face of the rod, and change alternately from one-half to the other. The numbers are large; those below ten (1, 2, 3, 4, 5, 6, 7, 8, 9.) are placed so, that the lower edge correspond to 0.25 and the upper edge to 0.75.

The numbers above nine (10, 11, 12, 13 and 14) are placed with the two figures one above the other; and in such manner that the bottom of the first figure is on a line with the top of the one-tenth division and the top of the figure on a line with the four-tenth division. The top and bottom of the second figure of the number correspond with the six-tenth and nine-tenth divisions.

The numbers are large and visible for long distances. The rod is painted white, the divi



Self-Reading Rod.

sions bright red and the numbers black. At every half foot the upper edge of the fifth division is extended, 1 inch long, over into the white field. The advantage of this division and numbering is, that each foot is on another half of the face of the rod, alternately at the right and the left side of the center line. The number seen by the leveler gives him directly the total of feet and tenths of a foot, the hundredth of a foot are easily and accurately estimated. The red color used for the divisions, enables the leveler to see the cross-hair on the colored tenth, as plainly as on the white tenth. This cannot be done when black color is used. The rod is composed of three separate lengths, each 5 feet long; they are connected with each other by flat irons and screw-bolts.

Figs. 2 and 3, show the details of the connection of two lengths. *A* indicates a wooden rib 2½-in. wide and 1 in. thick, *B* the face of the rod, 4 in. wide and ¾-in. thick, being connected with the rib *A* by a number of screws. Each end of each of the three lengths is protected against wear and tear by a flat iron, *a, a, a, a* Fig. 3, bent around its two sides and screwed firmly on to *A* and *B*.

Two flat irons, *b b* Fig. 3, are fastened along

the two sides of the rib *A* at the upper end of the first and second length.

The lower half of these irons are permanently screwed, by means of screw-bolts on to the upper end of the first and second length; their total length is 4 in. The upper half of the irons are penetrated by two bolt-holes each. The second length of the rod is put on the top of the first length, and the third length on the top of the second length. The wooden rib *A* fits exactly between the two flat irons *b b*. Two ¼-inch screw-bolts are then pushed through the two flat irons *b b* and the rib *A* and screwed highly.

One L iron, *c*, *c*, is screwed on the upper end of the first length and at the lower end of the second length and also on the upper end of the second and at the lower end of the third length. When the parts are put together, these L irons are in close contact, but are not connected by screws. The purpose of these L irons is to stiffen the junction of two lengths.

For common purposes two lengths (10 feet total length) are used; for levelling over steep hills, along mountain roads and across creeks and gulches, and for stadia work, the three lengths (total length 15 feet) are used. A 15 foot long rod saves many settings and therefore reduces the sources of error.

The dimensions given here are rather heavy. It is principally used in rough mountainous countries where solid construction is most important. For work on the level the dimensions can be reduced.

The results obtained by using this rod (ten years experience) have been very satisfactorily in reference to accuracy and rapidity of work; 6.6 miles, taking an elevation every 200 feet, were levelled with such a rod in 3½ hours and the level checked within 0.01 feet. The land was perfectly level and open. The level rod illustrated here, was used during this summer in the location of the new water conduit of the Spring Valley Water Works. The country traversed is of a rough nature and heavily timbered. The result of the levelling—9½ miles—was a difference of 0.35 feet which is sufficiently accurate, considering the wild and rough country, and that the location is to a certain extent only preliminary.

Journal of the Association of Engineering Societies. Vol. VI, No. I. November, 1886.

CONTENTS: "E. S. Chesbrough," a memoir by BENEZETTE WILLIAMS; "Cable Railways" and discussion, by W. H. SEARLES and members of the Cleveland Civil Engineers' Club; "Water Meters," by J. A TILDEN; "Street Pavements," a discussion by members of the Western Society of Civil Engineers.

The memoir of Mr. Chesbrough is the most complete yet published. The article on cable railways is a short description of the introduction of these roads into seven cities of the United States, with dates, length of line operated and a concise general description of the conduit, cables and engines. The discussion is mainly upon the comparative cost of working by horse and cable power. Mr. Tilden's paper on Water Meters, sketches the development of the meter as a mechanical device; it does not consider its value as a preventor of waste or as an adjuster of water rates. The street pavement discussion is in response to a query calling for the best pavement for a city residence street having limited travel. The opinions on this head vary considerably, but the paper is interesting.

Engineers' Club of Philadelphia.

Record of Regular Meeting, December 18, 1886. President Washington Jones in the chair, twenty-two members and one visitor present.

The Secretary presented, for Mr. Kenneth Allen, a table of Thicknesses of Plates for Stand Pipes, with formulæ, for the Reference Book.

Prof. L. M. Haupt presented the results of some calculations upon the Equilibrium and Stability of his system of Floating Deflectors, showing how conveniently the pressure upon the bottom may be regulated and the currents automatically controlled, by weighing the lower edge of the deflector. The angle at which the normal pressure is equal to the counterpoise was found to be 48° 12'; and the natural sine of this being 745, if the shield were equal in length to the depth, at this angle it would reduce the sectional area of the prism of discharge 75 per cent., and hence increase the velocity fourfold.

If, from any external cause, the velocity should become greater than that due to the weight, it would raise the shield, and *vice versa*. Such conditions would occur in tidal waters.

The weights and displacements of the several parts of the lateral deflecting system by which the prism of discharge is further augmented, were also presented, showing that under ordinary conditions of maximum velocity of tidal water for New York bay, there was a factor of fifteen (15) in favor of the buoyancy.

References were also made to the safety and durability of similar screw-disc mooring under more severe strains, and the fact that the late severe storms on the Gulf coast have not injured the jetties at Sabine Pass or at South Pass, was instanced as further evidence that the more destructive forces are at and above the surface.

The form and position of snow-drifts were cited to illustrate the effects of the action of movable fluid forces upon solids, and the phenomena observed by Mr. Rudolph Hering, as to the movements of the bottom currents in Lake Michigan being opposed to the direction of the wind, were alluded to as a confirmation of the general law of equilibrium.

The author further states that a current deflector of much more limited application, which had been tried in France, showed an economy of 90 per cent. in the cost of dredging.

The Secretary presented, for Mr. A. H. Howland, a paper upon Stand Pipes.

The general form, utility and economy of stand pipes and elevated tanks, are discussed.

A formulea for the thickness of plates is then presented; and the strength of riveted seams, the factor of safety, the reductions of thickness of plates towards top, etc', are discussed.

Tabular data, within practical limits, for thickness' dimensions and capacities, is given: also method of obtaining weights. The use of the micrometer sheet metal gauge for thicknesses, is advocated.

Form of joints, method of caulking, mode of setting, etc., are treated of, and the paper is concluded with a table of wind velocities and pressures.

The Secretary presented, for Mr. J. H. Harden, notes upon the Chester County, Pa., Granite, illustrated by specimens and photographs.

"Chester County has become noted for its granite (syenite), and recently three separate companies have been organized for the development of quarries in Warwick Township, on the line of the St. Peter's Branch of the Wilmington & Northern R. R., forty miles direct and sixty miles by rail from Philadelphia.

"An examination of the county from Springfield on the northwestern boundary of the county, to and beyond the falls of French creek, near Pughtown, a distance of more than six miles, discloses large boulders of syenite scattered over a wide extent of surface, culminating at certain points in boulders of huge dimensions, with the appearance of the solid 'ledge' (outcrop) from whence they were derived."

The author then describes the boulders which are now being quarried and cut up, many of which the photographers show to be very picturesque, and notes the various methods for getting out the stone.

"At any of these quarries there should be no difficulty in obtaining the largest sized stone required for architectural purposes, equal to the old established quarries.

"Regarding the quality of this granite, Dr. Charles M. Cresson, who has examined and reported (No. 4,740) thereon, says as follows:

'The samples of this granite consisted of a number of specimens of rough, undressed stone, and of a bar, and of several cubes for ascertaining the resistance of the stone to crushing strains, also of a specimen of polished stone.

'This stone is a syenite of fine and even texture, the component quartz being less in amount and in much smaller masses than in the Quincy granite.

'The so-called Quincy granite (with which I have been directed to compare the French Creek stone) is also a syenite. I find that the Quincy granite weighs about 167 pounds, and the French Creek about 191 pounds to the cubic foot.

'In the New American Cyclopædia (Appleton) it is stated that there is a granite on Staen Island which has been largely used in New York for paving, which is remarkable for its extream density, a cubic foot weighing over 180 pounds. This difference would give the Staten Island rock a decided advantage in the construction of submarine works like break-waters, requiring great stability.

'From this statement is it evident, therefore, so far as weight is concerned, the French Creek stone has an advantage over the superior Staten Island stone for submarine works.

'In consequence of the finer grain of the French Creek stone in addition to greater density, it also possesses greater toughness and resistance to wear than the Quincy stone, and experimental trials confirm this opinion.

'Mr. John C. Trautwine, in his tables on the Strength of Materials, gives the ultimate average crushing load for granites and syenites at 300 to 1,200 tons per square foot. Trials upon somewhat imperfectly prepared cubes of the French Creek stone showed that a force of over 23,700 pounds on each square inch, or over 1,500 tons on each square foot, was necessary to crush them. With cubes carefully prepared with parallel sides and plane surfaces as much greater force would have been required for the purpose.

'Experimental trials, by chemical means, of the ability of this stone to resist atmospheric influences calculated to produce disintegration, show that the French Creek stone is at least fully equal to the Quincy granite in that respect.'

'In my opinion the French Creek stone is a tougher stronger and more durable stone than the Quincy granite, and better adapted for building or paving, or any other purposes to which the Quincy granite is applicable.'

"No better evidence of the value of Chester granite should be required."

"At all three quarries, and particularly at that of the French Creek Granite Company, there is a large quantity of waste stone that would make excellent material for macadamizing roads."

"While there are only three organized companies there are yet many favorable locations for opening other quarries, and we should not be surprised to find Chester county supplying all the paving blocks and a good part of the cut granite, required in the City of Philadelphia and neigboring towns."

"These rocks (specimens shown), I have reason to believe, are not confined to Chester county. On the maps of the Second Geological Survey of Pennsylvania they are designated 'traps,' and some practical men have denied the correctness of the term as applied to these rocks."

"Other samples, believed to have had the same origin but different in composition, accompanying these notes."

HOWARD MURPHY,
Secretary and Treasurer

Engineers Club of St. Louis.

SPECIAL MEETING.

A special meeting of the Club was called for Tuesday, December 21, by the president to take action in regard to the death of Col. C. Shaler Smith. The meeting was called to order at 4.45 P. M., at Mercantile Library, President Potter in the chair, and twenty-three members present. The chair stated his reasons for calling the club together, announcing the death of Col. C. Shaler Smith, and calling attention to his valuable services to the club and his high standing in the profession. He suggested some action on the part of the club appropriate to the occasion.

On motion, the club decided that the chair appoint a committee of three to draft suitable resolutions to be presented at the next meeting of the club. Messrs. R. E. McMath, E. D. Meier, and J. B. Johnson, were appointed such committee.

The chair called upon members of the club for remarks. Col. E. D. Meier spoke of the lovable character of the deceased, and the pleasure of intercourse with him, both in business and socially. His versatility of talent and his familiarity with all the branches of engineering were remarkable. His original experiments and research were of great value to the profession. Col. Smith would be best remembered in St. Louis by his connection with the St. Louis bridge and the St. Louis Exposition, the success of the machinery department being due to him. Col. Meier related the accident which resulted in his death. Col. H. C. Moore spoke briefly of the standing of the deceased in the profession.

H. P. Taussig, formerly an assistant to Col. Smith, spoke briefly of his intercourse with him. Prof. Potter mentioned a letter dictated by Col. Smith very recently which was full of cheerfulness. Prof. Johnson spoke of the wonderful amount of work carried on by Col. Smith. The training received by the young engineers in his employ would perpetuate his influence on the profession.

On motion, it was decided that the club attend the funeral, and the secretary was directed to tender the family the services of pall-bearers, if no other arrangements had been made.

It was suggested that a committee on memoir be appointed at the next regular meeting. The matter of a floral tribute was left in the hands of the committee on resolutions.

It was directed that the club meet at 2823 Washington avenue, a half hour before the hour announced for the funeral services. Adjourned.

WM. H. BRYAN, Secretary.

TRADE NOTES.

The Hardness of Metals.

At a meeting of the Birmingham Philosophical Society, held at Birmingham on the 9th ult., Mr. Thomas Turner read a paper on "The Hardness of Metals," and showed a new apparatus for determining the relative hardness of metals, more particularly those used for chemical purposes. The method of determination by that instrument, he explained, was by scratching with a weighted diamond, the harder the metal the heavier being the weight. In steel rails, he remarked, the true hardness did not vary, as was commonly supposed, according to the tenacity, and that accounted for the difference which was often seen in the wear of railway rails. He also pointed out that in cast-iron the softest metal was really the strongest, contrary to the common belief. The paper was illustrated by specimens and charts.

Good and Bad Steel Rails.

A commission appointed in Russia for the testing of rails and ties has recently reported, after testing 107 rails and 58 tires. The results of the tests were, as to rails:—1. The best rails are harder than brittle rails. Hard rails are not necessarily brittle. 2. The best rails yielded less under the first blow of the drop weight, and had greater tensile strength, on an average 92,500 pounds per square inch; their extension was less by about 19 per cent., and they had less diminution of section by from 35 to 40 per cent. 3. The best rails contained more carbon and more manganese than brittle rails, and less manganese than excessively worn rails. It was further observed that a certain relation—not stated—between the manganese and the carbon in the rails tested appeared advantageous, and also a relation between the silicon and the phosphorus. The samples tested by the commission came from forty different roads, and had undergone most diverse experiences, with lives from a few months to ten years, and traffic varying from a few tons up to 20 million tons. The rails were of Russian, English and French make. The commission found very remarkable differences in the amount of silicon and phosphorous in the best as well as in the worst rails, and the proportion between these elements also varied greatly. In the best rails, however, the proportion between them did not vary much, and averaged 4 of silicon to 1 of phosphorus, while in brittle rails these elements stood to each other as 3 to 2.

Exhibits at the American Institute, New York December, 1886.

The exhibition of James H. Lancaster, inventor, civil and mechanical engineer and patent agent, at the American Institute Exhibition, New York City, was one of the most novel, practical, and interesting to be found in the vast hall. Probably the most wonderful was a machine that looked like a huge octopus. It is a self-penetrating grapple, digger, or dredge, which will automatically dig, raise and discharge any kind of mineral, gravel, mud, phosphates, rock, etc. He had also on exhibition the well-known Lancaster tools and electric lighting plant and his new caloric engine for pumping and power, and also for working electrical and other machinery. Another of his exhibits was a newly-invented ore crusher, adjustable to all grades of fineness of stone, rock or other substance. He was awarded two first prize medals for his exhibits. In addition to all these inventions this gentleman conducts a large patent agency concern at his office, 187 Broadway, New York, which with his intimate and practical knowledge of inventions, necessarily makes this department of his business a sort of Mecca for those desiring to obtain, license or sell patents. Mr. Lancaster has secured prominent space at the forthcoming American Exhibition in London (May, 1887), where he will be largely represented by important American inventions. Messrs. Edmond Eaton & Co., 28 Martin's lane, Cannon street, London, E. C., will have charge of his various exhibits. Mr. Eaton will also be pleased to attend to all inquiries by English inventors relative to Mr. Lancaster's American and Canadian patent agency business.

Foreign Iron and Steel Trades.

Reprinted from the Iron and Coal Trades Review, Dec. 18th

FRANCE.—The 10,000 metal sleepers on the Severac system required by the Northern Railway Company will be supplied by the Northern and Eastern Company at 13 fr. each, a Maubeuge firm asking 13.84 fr., and the Providence Company 20.70 fr. The tenders have been opened for the trusses required for the roofing of the Exhibition Buildings. The engineer's estimate was 320 fr. per ton, but the offers were—(1) 278.40 fr.; (2) 283.92 fr.; (3) 286.40 fr.; and (4) 287.10 fr. There is some probability, after all, of the 900 foot Eiffel iron tower being abandoned in connection with the Paris Exhibition of 1889. It was proposed to erect it over the main entrance of the Exhibition grounds, but some of the engineers' committee believe that the erection of such a tower is impracticable. The *Bulletin du Comité des Forges* for October, 1886, has just been issued, and gives particulars of imports and exports of iron and steel for the first nine months of the year.

The imports of pig and manufactured iron and steel during the nine months were:—

	1886. Tons.	1885. Tons.
Pig iron	122,923	137,912
Manufactured iron	30,246	34,636
Steel	7,847	10,008
To'als	161,016	182,556

The total for the nine months was thus 161,016 tons, this being 21,540 tons, or 11 per cent., less than in the corresponding period of 1885. The exports of iron and steel of all kinds, for the nine months amounted to 107,632 tons, as compared with 104,910 tons in the first nine months of 1885. Statistics are given relative to the exports from Belgium, Great Britain, and Germany; also particulars of the orders distributed by the French railways during the third quarter of the year. Some months ago we reported the constitution in France of a syndicate of manufacturing firms, for the purpose of obtaining from the Chinese Government the concession of a number of public works. This syndicate was under the patronage of the Comptoir d'Escompte, and among the members were the Fives-Lille Company, the Mediterranean Forge and Shipbuilding Company, the Loire Manufacturing and Shipbuilding Company, the Cail Company, the St. Chamond Forge Company, the Marine Steel Company, etc. The syndicate has sent out a deputation to China, directed by M. Thévénét, engineer, and this deputation has been so far successful that Li-Hung-Chang has entrusted the syndicate with the execution of the work necessary for the improvement of Port Arthur, the total cost of which will be 8,625,000 fr. Attempts are being made to reconstitute the Longwy syndicate of iron manufacturers, but not with much success. A French engineer has obtained a concession for the construction of a railway from Teheran to Shabdulazm, a run of four miles. The capital for the undertaking is chiefly Russian.

BELGIUM.—Employment is fuller at most of the works than it was in the early autumn, and orders are more numerous and for larger quantities. A heavy demand for old rails has sprung up, both for home consumption and for export. Messrs. Tardy and Benech, of Savona, in Italy, have bought 25,000 tons of old rails, taken from the Belgian State Railways, and have given a fair price for them—60 fr. per ton. Some offers have been made in other quarters at 68 fr., and even 72 fr. The rails referred to above were placed on the lines prior to 1880, and the last order for iron rails was given out on January 1, 1880, under the administration of M. Sainctelette. The Belgian forge-masters have had a conference at Brussels, and have determined to take no less than their present prices of merchant iron at least during the first half of next year. As regards joists, the value of these will be determined very much by the state of the demand, which is now poor, the erection of large buildings being almost suspended for the winter season. The bridge at Cernavoda-Fetesci, which is to be erected over the Danube, will require 25,000 tons of iron and steel, and in the Argentine Republic the water-works to be constructed will call for the use of 10,000 tons of plates, angles, etc. The 1,200 tons of iron rails required in Sweden will be supplied by the Cockerill Company of Seraing, at a price above that which has ruled for some time past. For the fish-plates wanted by the National Society of Secondary Railways, Cockerill has undertaken to accept 135 fr. for 135 tons, while Boël at La Louvière, will supply 130 tons at 135 fr., and Ougrée, 150 tons at 135 fr. For the guard plates, Cockerill takes 130 fr. per ton for 65 tons, and Boël 130 fr. for 35 tons. The orders for 10,000 tons of rails for the Seconday Railways have been divided among the following firms, which each accepted at 115 fr. per ton:—Cockerill, 3,500 tons; Boël, 1,500 tons; Thy-le-Chateau, 2,000 tons; Angleur, 1,200 tons, and Ougrée, 1,800 tons. The prices of pig-iron are very firm, forge qualities being strong at 39 fr., and considerable orders have been placed at that figure. In Belgian Luxemburg that rate is taken for foundry qualities, while in the Charleroi district the best forge is 49 fr., ordinary forge 44 fr., and common 39 fr. An official communication to the Luxemburg Chamber of Deputies says that the iron mining and smelting industries of the Grand Duchy in 1885, employed 6,000 persons, and of this number 3,000 were foreigners. In the Esch-sur-Alzette district, 1,500 were employed; in that of Rumelange, 1,300; in that of Differdange, 1,100; in that of Rodange, 900; and in that of Gare, 200. One blast-furnace is to be re-lighted at Rodange, and another at Esch.

SELECTED MISCELLANY.

IT is stated that there are at present 84 railways and tramways employing electricity as a motive power.

THE most famous man in Yale College died Wednesday. He was known as "the half back and goal kicker.. —probably some sort of higher mathematics.—Washington *Post*.

ONE of the German manufactories is producing paper pipes for water, gas, subterranean telegraph wires, etc. They are really made of hemp paper and asphalt, and to cut the material is like cutting hard wood.

NOTIFICATION is given of the intention of the London Metropolitan Board of Works to apply for a bill enabling them to provide a new means of communication across the Thames at Blackwall, consisting of a tunnel under the river. It will consist of a single tunnel or two parallel tunnels, and will be for the use of carriages and carts, as well as foot-passengers.

THE prospectus of the City of Genoa Water-Works Company (limited) has been issued. The share capital is $1,500,000. About eight miles from the city a large reservoir will be constructed, covering an area of upwards of twenty acres, with a storage capacity of 150,000,000 to 200,000,000 gallons, or a reserve of over thirty days, supply for the city.

IN the celebrated Aspen mining case, now being tried in Denver, there is used a model of Aspen mountain, made of terra-cotta. Its base is about 8 feet square, and its height 3 feet. It represents that part of the mountain on which the controverted properties are located, and was made according to careful measurements, the scale being 50 feet to the inch. Valejo and Spar Gulch were represented, and all the surface contour of that portion of the mountain

THE Polytechnic School of the Washington University, of St. Louis, Mo., is now well equipped for laboratory tests. It has a 100,000-pound Riehle testing machine arranged for tension, compression or cross-breaking; it is operated by hydrostatic pressure generated either by hand or steam power. This machine, with another of 10,000 pounds capacity, is used both for the benefit of the students and also for making tests for outside parties.

INGENIOUS METHOD OF DAMMING.—Taking advantage of the well-known fact that certain salts increase their volume by the absorption of water when hardening into crystals, Mr. Tietjens, of Stassfurt, has recently patented an ingenious method of damming back the flow of water in shafts. He takes calcined soda, anhydrous alum, kieserite, or oxychloride of magnesium, mixes them into a paste, and then injects it by a suitably arranged pipe into the rock fissures. As the paste hardens it swells, thus completely filling the interstices, and so rendering the shaft water-tight.

SLAG WOOL FOR LAGGING.—The New York Steam Company on their new lines of mains, now being laid, use slag wool for lagging. A brick floor is laid; a wall built up on each side of the pipe, and the wool is packed loosely round the pipe. Resembling cotton wadding in appearance, with no long filaments, the slag wool can be pulled apart or broken easily. It is in color greyish-white, and is full of small globules, or beads of green glassy slag. Ranking high as a non-conductor, it is extensively used for lagging boilers, cylinders, steam pipes, etc.

THE most common adulterant of white lead is permanent white, or sulphate of baryta. This admixture may be recognized by boiling a small quantity of the pigment in a glass test tube or flask, with nitric acid diluted with an equal measure of water. The white lead dissolves, but any sulphate of baryta remains as a white residue. The residue should be allowed to settle, the clear liquid poured off, and the deposit again treated with nitric acid and then boiled with water.

THE new glass made by Professor Abbey and Dr. Scott contains fourteen instead of the six substances of ordinary glass. The most essential elements of which it is composed are phosphorous and boron, neither of which is used in common glass. With the old glass the full power of the microscope was the discernment of the one five hundred thousandth part of an inch, and with the new glass it is claimed that the one two hundred and four million seven hundred thousandth part of an inch can be distinguished. When the discovery was first made Carl Zeiss, the manufacturer, in whose place the experimentalists had worked, was in favor of getting out a patent, so that the discovery might prove a most profitable one, but the fact of the experiments having been conducted with funds supplied by the Prussian Government prevented the discoverers from making it a private enterprise, and compels them to make it a public benefit. The difference between the new and the old glass consists in the refraction of light. The glass is shortly expected on the market.

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Accompanying this issue of ENGINEERING NEWS *is the Index for Volume XVI., July to December*, 1886; *also a portrait of Mr. Jas. B. Francis, of Lowell, Mass. Subscribers will please to see that both supplements are supplied them.*

IN this issue we publish the first part of the paper of Prof. J. A. L. Waddell on Civil Engineering Education. It is an important topic and one of vital interest to our future progress in the sciences and arts. Practically nothing has been said upon this subject by those best fitted to discuss it since the paper read before the American Society of Civil Engineers by Thomas C. Clarke, C. E., in June, 1874; Twelve years now span an advance in ideas, knowledge and practice that we trust may make itself felt in this paper and the discussions that are to follow it. In any event it will be fully treated both by the most prominent and experienced of our educators of engineers, and by well-known engineers in active practice; and a general presentation of their experience and opinions must be beneficial in its results to the coming generation of both students and teachers, if it does not work an immediate revolution in present practice.

THE pungent and to us at least very convincing answer of Mr. Fernie to his Anglo-American correspondent, in *Engineering* of Dec. 3, respecting the comparative merits of American and English locomotives has called out a rather amusing and often contradictory correspondence in that journal. Some of the writers with true English pertinacity simply repeat the charges which Mr. Fernie answers, and reiterate that while American engines will do very well for "a new country where the railways are of the rudest construction and unfenced,"—"where the railways are fenced, the road smooth and high speed a necessity, there are no locomotives in the world superior to those of Great Britain."

Just what fencing has to do with the details of construction in a locomotive is a conundrum we must leave to the author for a solution; and from an engineering standpoint we would say that the machine that can make so good a record for running and repairs—as do the American engines—on the class of roadbed our English cousin imagines, must have strong, inherent merit, and ought to do much better on a "smooth" road. The "comparison is ridiculous"; but Americans may differ in the point of view from the correspondent quoted.

Other Englishmen discussing this question are more temperate and see a breaking in upon traditions and an honest attempt to lift the English locomotive out of a very deep rut. The question of crank-axles, wrought-iron wheels, inside cylinders, plate framing, copper fire-boxes, etc., is all fought over again with varying success. The wrought-iron wheel is stated to be the "most enduring and most reliable part of the English locomotive," a statement that may be taken as faint praise for the other peculiarities of design; and the same writer says that English cast-iron lacks the qualities which make it safe to use cast-iron in wheels in America, and further that when cast-iron has been used in the wheels of freight-cars in Great Britain, the metal is put into a shape inferior to American practice and they lack symetry and neatness of appearance. The crank-axle is characterised as a monument of the machinist's skill, but it is questioned whether it is scientific in design or even decently mechanical; the inside cylinder is also objected to by some correspondents. These are frank and manly admissions, and prove that some English engineers, at least, are ready to break away from precedent and improve upon existing methods even if the original ideas do come to them from across the sea.

A third correspondent sagely remarks, in discussing the weight of English engines, "of course we know that any English engine would crush an average American track." We are in doubt as to what this "average" may be as painted by the fervid imagination of a correspondent who would probably expect to see wigwams pitched in our City Hall Park and our worthy city fathers in feathers and warpaint; but as our average track is laid with steel-rail, approaching at least 70 pounds to the yard, and on good white-oak ties laid much closer than in the English practice, we would bet on the track every time in competion with "any English engine."

We regret to see the bitterness displayed in some of this correspondence. The topic is one that by their own admissions is more important to Englishmen than to Americans. Even if hastily and cheaply constructed roadbeds and crooked alignment in America, did originally make imperative a broad departure from the practice of Stephenson and his contemparies in track, engines and rolling-stock generally; this road-bed, and alignment in many cases, has improved with our advance in knowledge and wealth until it is fully the equal of the English average for all practical purposes. And the good points in engine construction, originally the offspring of necessity, have been further perfected and elaborated until the American engine is a well-nigh perfect steam motor.

Mr. Fernie graphically points out the characteristics of the American people which have given the world the reaping machine, sewing machine, machine made watch and an infinite variety of appliances that are daily in use even in England, and of which Englishmen loudly sing the praise. This same mechanical skill and inventive talent has perfected the locomotive, and only an inborn stubborn adherence to time-honored custom and precedent prevents their good points being recognized abroad. The world belongs to the engineer and inventor and no local feeling should be permitted to stand in the way of a full recognition of the merit of his work.

THE railway construction in the United States for the past year will foot up to nearly 6000 miles, as opposed to about 3000 miles for 1885. Experts prophesy a mileage of somewhere between 9,000 and 10,000 of new track for 1887; and including side track, extensions and repairs a consumption of sufficent rail to lay about 16,000 miles of road.

From all indications railroad building will be pushed with a vigor unknown since 1882, when about 12,000 miles of new road were built. But while that was an abnormally speculative year and nearly one-third of the outlay was lost by subsequent bankruptcy, the present outlook seems to point towards sounder results. From 20,000 to 30,000 miles of new road are estimated as projected; though all figuring on this head is practically guess work.

THE ring which has for a long time controlled the Pitch Lake of Trinidad is now said to be broken; and under the new order of things licences "to dig" will be issued under a royalty of about 62 cents per ton.

This figure should satisfy all concerned as to price; for four years past crude asphalte has been worth $5 per ton, and the boiled (*Epuré*) just about double that sum in England. The price in the United States, at New York, has been lately about $11.00 per ton. The export to England in 1885 was 28,505 tons; the amount consumed in the United States can not be exactly stated.

IN the first eleven months of 1886 230,000 emigrants sailed from English ports to this country, an advance of 50,000 over the corresponding period of last year. Of this increase the English and Scotch numbered 13,000 the remainder were foreigners; Irish emigration was 18,000 less than last year.

Canada received 29,000 emigrants, and Australia 40,000. *The Colonies and India* figures out that on the whole England and Scotland lost last year, 163,000 of its inhabitants as against 140,000 in 1885; and Ireland 59,000 as against 58,000 in last year. Only 1000 foreigners were among the emigrants to Australia.

THE government of Victoria is contemplating the establishment of an "experimental irrigation colony". It has already entered into a provisional agreement with Chaffey & Bros., of California, and successful irrigators, to this end. This firm proposes to occupy a grant of 50,000 acres of "mallee" land on the Lower Murray river and to expend $1,500,000 in the course of 20 years in clearing the land, establishing irrigation and making a settlement with small freeholders. The land is to be held on an occupation lease until $25 per acre has been expended, and then the Messrs. Chaffey are to have the fee-simple.

They are to have the right to purchase 200,000 more acres of the same country on the conditions of spending in improvements the sum of $2,100,000, and pay $5 per acre for the land. The conditions agreed to are stringent, the firm must not at any time retain over 5,000 acres of cultivated and irrigated land in its own possession; and the irrigated land is to be sold in blocks of not over 80 acres, if intended for fruit culture, or 160 acres for other farming purposes. Each block will carry certain water rights.

The Victoria government in the conditions imposed seems determined to allow no greedy corporation to monopolize land in that section by the tens of thousands of acres. And may perhaps in this have taken a leaf from our own experience in Texas and elsewhere, where huge land grabs by native and foreign holders are now causing serious trouble.

SHEFFIELD is very much disturbed over the armor question. The British war office is said to be asking for 18-inch steel plates and Schneider & Co., of Creusot are the only parties that can make them. One party in Sheffield composed of those who own no works ask why Sheffield does not keep up to the times; while those who own works, making compound plates, assert that steel faced armor has always broken up the shot more than did all steel plates.

The *Iron and Steel Trades Review* introduces an incognito gentlemen, who points out that at the recent Shoeburyness experiments a 12-inch chrome (steel) shell went clean through a 16-inch Sheffield plate while at Spezzia recently a 6-inch shell discharged at an 18-inch chrome plate penetrated only 9 inches and then rebounded without being damaged.

It is also stated that the steel faced plates at Spezzia were smashed to pieces at the first shot while the all steel plates, with the exception of the holes made by the projectiles, stood the tests and remained intact.

Experts' Report on the Sewage Disposal of Providence, R. I.

Messrs. Joseph P. Davis, Rudolph Hering and Robert Moore, the engineers appointed by the American Society of Civil Engineers to examine the plans proposed by Chief Engineer Samuel M. Gray for the sewerage system and sewage disposal of Providence, R. I., have handed in their report under date of December 21.

These gentlemen, after carefully examining the plans, profiles and estimates of Mr. Gray and also the general field and site of proposed works, emphatically endorse the system as proposed by Mr. Gray with little or no modification.

In their report the several plans of sewage disposal open for adoption are briefly described; but as this matter has already been fully treated in connection with Mr. Gray's original report it will need no further mention here. In considering the application of these various systems to the conditions and requirements of Providence, the disposal at Seekonk Plains is first discussed by the commission.

The objection to this scheme is that if broad irrigation is adopted the amount of available land (less than 1,200 acres) is barely sufficient for present demands; with no margin for the future. This land is fairly suitable for intermittent filteration, but land of equally good or better quality can be obtained for this purpose at Warwick Plains at a much lower rate; and this latter point is more remote from habitations. The Seekonk Plains are therefore abandoned as part of the scheme investigated.

Crude disposal at Field's Point was reported upon as by far the cheapest of the proposed schemes; but the citizens of Providence are opposed to this method of disposal. And as the shores in the vicinity are used for summer residences and pleasure resorts, and oyster and fishing interests exist, this objection is well held. The float experiments of Mr. Gray also demonstrate the fact that floating impurities would be very likely, under certain conditions of winds and tidal currents, to be deposited on the shores and become a nuisance, the commission therefore, weighing the health and pleasure of the people as against the comparative cheapness of the scheme, regard this method of disposal as inadmissible.

At Warwick Plains they find 2,200 acres of land available for irrigation with soil of good character. But this is not sufficient, for the future Providence with a population of 300,000, to permit of broad irrigation. For this reason and because they find intermittent filtration the cheaper and better method, all things considered, the commissioners used the latter system in their estimate of cost. Taking Mr. Gray's estimate for the intercepting sewer system at $2,195,973 and assuming that each acre properly graded and under-drained will, on the yearly average, dispose of 45,000 gallons daily, (equivalent to the English basis of 1,000 people per acre), the experts find that the total cost for intermittent filtration at this point will be $4,520,000; this includes the immediate purchase of 1,000 acres of land and the special preparation of 200 acres for filter beds.

The yearly cost of operating, including the pumpage of the sewage and care of the sludge, is estimated at $28,000; the subsequent cost of distributing the sewage on the land and the care of the filter beds are assumed as covered by the sale of the products. The engineers are decidedly adverse to any idea of profit to be derived.

Mr. Gray recommended the precipitation of the sewage at Field's Point by chemicals, and this was the scheme next considered by the commission. On a separate estimate of cost for raising, storing and treating the sewage, they find so little difference that they adopt his figures of $3,700,000. With a dry weather flow of 9,000,000 daily, they estimate the annual cost of pumpage and treatment at $65,000; as experience is lacking in this country, they say it is hardly possible to give exact figures, but believe this may be reduced to $53,000.

The report concludes with a careful comparison of the precipitation scheme at Field's Point with the intermittent filtration scheme at Warwick Plains. The English experience and precedent is quoted at length; and while both of the above named schemes would be satisfactory solutions of the problem, from a money stand the Field's Point project shows a difference in first cost in its favor of $920,000. When the annual cost is considered they find the following results:

For the filtration scheme:	
Interest upon $4,620,000 at 3½ per cent	$161,700.00
Operating expenses, including pumping and care of sludge	28,000.00
Total	$189,700.00
For the precipitation scheme:	
Interest upon $3,700,000 at 3½ per cent	$129,500.00
Operating expenses, including pumping and cost of precipitation	65,000.00
Total	$194,500.00

As the cost of the heavier pumping required to lift the sewage to the Warwick farm is liable to increase from repairs, etc., and the maintenance of a complicated system of tile drainage will also be expensive, this scheme contains elements of increasing cost. Whereas the precipitation process is likely to be reduced in cost below the preceding estimate, as before mentioned. For these reasons the annual cost is expected to be in favor of the latter process. The chemical treatment is also simpler than that by filtration; for the latter involves farming and market gardening, requires trained supervision, and many employes, with all the trouble this might entail on a city entering into what is really a business venture rather than the mere handling of a mechanical process.

The commission sums up its conclusions as follows:

1. That in order to cleanse the rivers and the cove, all sewage must be kept out of them, except in time of storms.
2. That this can be accomplished only by a system of intercepting sewers, substantially such as that proposed by Mr. Gray.
3. That of the various schemes for final disposal of the sewage, the two which we consider best are those for intermittent filtration at Warwick Plains and chemical precipitation at Field's Point.
4. That either of these will dispose of the sewage in a satisfactory manner and in a way to free the city from nuisance.
5. That in this respect the two plans are substantially equal.
6. That of these two the precipitation scheme is, in first cost, the cheaper by $920,000.
7. That in annual cost the balance will probably be in favor of precipitation.
8. That the organization needed for precipitation is simple, having in view but a single object—the purification of the sewage.
9. That the organization at Warwick Plains will have two objects, one the purification of the sewage, the other the somewhat complicated business of conducting a large farm with a view to profit. In other words, it will be a business venture in which the city should not embark unless there be no satisfactory alternative.
10. For these reasons the scheme of chemical precipitation at Field's Point, is, in our judgment, the one best worthy of adoption.

Captain Lundborg's 24-Knot Yacht.

Washington dispatches assert that Senator Stamford, of California, has made arrangements with Captain Lundborg to build a yacht that is to make 24-knots or 27⅔ statute miles per hour. The plan proposed is decidedly novel in naval architecture, and results from experiments made by Captain Lundborg in towing models through a trough some 200 feet long, by which he arrived at the same conclusions reached independently by Froude, namely: that the greatest frictional resistance is at the surface of the water.

From these experiments the Captain evolved his midship cross-section which has an almost perfectly flat bottom, of much greater width than is usual, with concave sides, which commence flowing outward at the water line, the deck being narrower than the bottom. This cross-section is entirely free from plane surfaces, except on the bottom, and allows more than 30 per cent. greater capacity than the established type, with the same length and a less draft. In addition vessels of this cross-section roll more slowly than those of the

usual form, and the metacenter rises with the greater beam much more rapidly than the center of gravity, making the vessel much more stable, and obviating the necessity for water ballast, or the special loading that is necessary in our trans-Atlantic liners.

As experiments showed that it was immaterial whether the dividing wedge, either at the bow or stern, was horizontal or vertical and as twin screws would present many advantages over the single screws if it were not for the resistance offered by the brackets required to support them and their shafts, Captain Lundborg has designed a vertical bow, while the wide part at the bottom of the hull ends in a wedge with a horizontal edge affording a firm support to the shafts for the two screws that will be more apt to be submerged than a single screw and will also be free from the action of the eddying water that follows a vessel moulded in the usual manner. At the water line the lines are very fine and much like those of the best steamers.

It will be seen that all of these departures from the standard designs, which have not been materially modified for over 1,000 years, are based either on theories or on experiments made with small models, and persons will be found to doubt the wisdom of Senator Stamford in expending $600,000, the estimated cost of the new vessel, on an experiment. It can hardly be doubted that the Senator has been actuated in this by a patriotic desire to do good to his country.

The vessel will be built by the Union Iron Works of San Francisco, and it is said will be offered to the Government at its cost if it proves satisfactory.

Captain Lundborg has been trying for two or three years to get the naval authorities at Washington to adopt his plan, and about a year since delivered a lecture before the American Yacht Club which was received with considerable enthusiasm, but no one in New York had the helpful enthusiasm of the California Senator.

Triple Expansion Steam Engines.

It would seem as if the era of triple expansion marine engines was beginning to dawn. Certainly the reports announce a decided fuel economy in the use of those engines, in which the steam is expanded successively in three cylinders before being condensed. That any superior fuel economy is due to the triple expansion, we greatly doubt, and are rather inclined to credit such fuel and steam saving, as may be effected, to the high initial steam pressures in use in these engines, viz.: 160 pounds per square inch and over.

We question whether it is true economy to expand steam more than eight times its volume in marine practice, when all items of current expense are taken into account, such as cost of fuel, freight value of space consumed by steam machinery and fuel, interest and depreciation on steam plant and the like.

This conclusion is also borne out by the investigations of Messrs. Marshall and Weighton (see ENGINEERING NEWS, October 30, 1886), on the basis of the least weight of steam machinery and fuel for a given horse-power effect; consequently this expansion causes the least displacement of vessel and the least resistance to motion of vessel, and takes away the least space for freight capacity.

With a ratio of expansion of eight, and with 160 pounds initial steam pressure, ordinary compound engines, in which expansion takes place successively in two cylinders, should show a fuel economy not much, if any, inferior to triple expansion engines, while the weight and cost of steam machinery, and the displacement of vessel will be less. We should certainly think that ordinary compound marine engines ought to be given a chance to show what they can do with 160 pounds initial pressure and over, before settling upon triple expansion as the correct thing in marine practice.

Nor should the decision be based on relative fuel economy alone. The object to attain is to secure the power for the least current expense, such expense being the sum of interest on first cost and depreciation of steam machinery, cost of fuel, including its freight value, and other current items of the power account. The freight value of space occupied by the steam machinery should also be considered in the problem. A superior fuel economy, as heralded to be obtained by the use of triple and quadruple expansion marine engines, is no proof that such fuel economy is due to the triple or quadruple expansion element, nor is the attainment of such fuel economy undoubted proof of the superior commercial economy and unquestioned value of these types of engines for marine practice. (Parenthetically we may observe that their use for stationary purposes is out of the question.)

As we have intimated other elements enter the problem. They should be duly considered and be given their full weight before coming to any hasty decision as to the relative value of ordinary and triple compound steam engines. There is always danger of being misled by a one-sided presentation, and in steam engineering, certainly, the alleged basis of a small saving of fuel (which when translated into dollars and cents is frequently found to be actually over-balanced by other necessarily increased costs) has often been the source of much erroneous practice and consequent waste of money.

We certainly do not believe in one-sided representation, and so we hasten to say that if the triple expansion marine engine comes out ahead in the class of competition we have sketched, well and good. Reliable data for such comparison, are, however, at present not at hand, and until they are, we would simply call the attention of all interested in the problem to the fact that there are justly two sides to the question.

Annual Report of the Commissioners of the District of Columbia.

Messrs. W. B. Webb and S. E. Wheatley and Col. Wm. Ludlow, U. S. Engineers, Commissioners of the District of Columbia, have presented their annual report for the fiscal year ending June 30, 1886. The following is an abstract of the parts of engineering interest:

Under the head of water supply, the consumption per capita is put down at 150 gallons daily for the citizens living within reach of the mains; this is very properly characterized as due to excessive waste, and the Commissioners hope to regulate this consumption in the course of time. The quality of the water is wholesome and acceptable, but it is at times turbid.

The report says little about the sewerage except to note the completion of the large boundary sewers in the past season. The summary of street paving does not practically differ from that given lately in this journal; the areas covered with modern pavements and those still quite unimproved are about equal. In the whole street area, 5,260,000 square yards, 30 per cent. is covered with asphalte, coal-tar distillate and asphalte blocks; 10 per cent. is paved with granite and trap block; 10 per cent. with cobble and rubble; 4½ per cent with macadam; 14½ per cent. with gravel, and there are still 7,000 square yards of wood block, and 1,600,000 square yards are yet unimproved. The total expenditures for paving in the nine years ending July 1, 1887, are $2,636,000. Lacking adequate appropriations, the street repairs have been somewhat neglected, and the Commissioners recommend that $90,000 be appropriated for 1888, and $100,000 for three successive years thereafter, instead of the $50,000 of past years.

The contract price for street cleaning was 27½ cents, for 1885, and 25½ cents per 1,000 square yards in 1886, the number of sweepings on any one street are reported as insufficient, and an increase in the street-cleaning appropriation is asked for so that the present service can be doubled; $70,000 is recommended for 1887-88.

The question of the concentration of the numerous railway lines entering Washington, and their removal from existing streets is again earnestly pressed upon Congress. The lack of proper bridge communication over the Potomac is noted as a serious inconvenience; and as the Federal Government will soon be in control of the old Aqueduct Bridge, it is hoped that it will be at once replaced by a suitable structure. The Commissioners approve of the action of Congress for a handsome bridge between Washington and Arlington, but do not want the District revenues to be taxed therefor. They recommended another bridge across the Eastern Branch as urgently needed; as also the replacing of the present unsatisfactory bridges across Rock creek.

Capt. Thomas W. Symons, United States Engineer, reports that the expenditures for the year in the engineering department were, $607,988.20; the purchase of water meters are recommended to reduce excessive waste, as the income from water rents is insufficient to meet the expenses. It is recommended that hereafter the practice of laying a main in the middle of the street to supply both sides be discontinued, and that instead a service pipe be laid under each side-walk. While at first more expensive, this will obviate the breaking of sheet asphalte pavements, and their after unsatisfactory repair; leaks under these pavements also rarely show themselves, and long continue to waste water, as has been proven by experience. Capt. Symons thinks much of the present waste due to imperfections in the distribution system. Improved taps, stop-cocks, hydrants, etc., are being prepared for submission in the hope of improving the efficiency of the service.

It is recommended that a special department of sewers be established, and the estimates for the coming year include $1,600 for the salary of a superintendent of sewers, $1,200 for one draftsmen and $1,000 for a clerk. It is estimated that $72,365 will be wanted for new sewers in 1887-88, and $48,710 for pipe sewers. Sewage is now disposed of by simply emptying it into the Potomac and Rock creek; the Commissioners think that the time has arrived to intercept this flow, and dispose of it in a proper manner in deep water, and asks for $30,000 for the preparation of plans for sewage disposal and commencement of the work.

The Panama Canal.

The *Bulletin du Canal Interoceanique*, for December 1, gives the following as the work done on the Panama canal in October last:

Total work done at eleven points, 941,000 cubic metres, or 1,230,828 cubic yards. The chief points operated upon were,—Colon, Gatun, Obispo and La Boca, with 118,000, 209,000, 103,000 and 183,000 cubic metres respectively. This is an aggregate increase over the cube extracted in September of about 50,000 cubic metres.

Maintenance of Paris Streets for 1887.

The *Bulletin Municipal Official*, of December, 8th, gives the following as the amounts finally appropriated for repairing and cleaning the streets of Paris for the coming year:

The total for repairs to street paving is divided as follows:—

Stone Pavement	3,345,603	francs.
Macadam "	3,000,000	"
Asphalte "	517,000	"
Wood "	1,783,350	"
General Expenses	155,550	"
Total	9,091,503	francs.

This is a total of about $1,800,301; and the surface to be kept in repair is equal to 8,517,500 square metres or 10,221,000 square yards, an increase of 400,000 square metres since 1880. To the above is to be added 1,238,750 francs, or $247,750, for general renovation of public ways, and 1,800,000 francs ($360,000) for repairs to and renewal of bituminous foot walks, areas, alleys, etc.

The sum of 5,572,000 francs ($1,114,400) was at the same time appropriated for sweeping and watering streets, and removing snow and ice; the sweeping item alone footed up to nearly one million of dollars.

Judging from the vigorous and sometimes bitter and personal debate, as reported at full length in the official organ quoted above, the fixing of annual appropriations is very much the same kind of a proceeding in France as it is in the United States; the engineers contended most earnestly for the full amounts of their estimate, and the Administration just as persistently shaved them down in almost every case.

The Purification of Water by Iron.

We have more than once noted the results of the Anderson process for purifying water from coloring matter and organic contamination by the use of iron, as applied at Antwerp. Mr. W. Anderson, M. Inst. C. E., has lately read another paper upon this subject before the Society of Arts, of England, and of this we make the following abstract:—

Refering first to the Medlock patent of 1857, in which some practical results were obtained by suspending iron in the water tanks, the author passes on to the discovery of Prof. G. Bischof, eighteen years ago, and the invention of the now popular domestic filter known by his name. In these filters the water was first roughly filtered and then passed through a layer of iron in coarse, granular condition, then through a stratum of native peroxide of manganese and finally through a bed of ordinary filter sand. In applying this on a larger scale, Prof. Bischof put the water through a layer of sand, first, then through a layer composed of three parts, by measure, of coarse gravel to one of granular iron and finally through an ordinary filter sand. The practical result noted was that iron was dissolved first in the water at the rate of one-tenth grain per gallon and that during this process, and subsequent deposition, there was a powerful effect produced on organic matter held in solution.

The Bischof process was in use sometime at Antwerp on a large scale, cleaning the water almost perfectly; but owing to the greatly polluted condition of the Nethe river the iron had an abnormal amount of work to do, and the upper layers of gravel and iron were quickly choked by the dissolved impurities. It was curious to note the appearance of the iron filters. All that could be seen from above, when the water had been drawn off, was the ordinary surfacce of a sand filter, which had to be cleaned in the usual way about every fortnight. On digging through the sand no change could be detected till the spade arrived within a couple of inches of the iron mixture, when discoloration became apparent, and this continued to increase till the layer of iron was reached. For 6 inches or 8 inches the gravel and iron particles were thickly coated and mixed with a redish, slimy substance, the product of the chemical action of the iron. Deeper down the mixture was of an intense black, and had apparently remaind unchanged during the four years the filters had worked. The upper 6 inches of the iron mixture had to be removed and washed about every six months, but no difficulty was experienced from any concreting together of the mass. There is very little doubt but that with purer water the inconvenience and expense caused by the great deposition of slimy matter would have been less severely felt, and Mr. Anderson believed that in the case of domestic supplies and moderate sized installations Professor Bischof's system is the best yet introduced. The behavior of the filters at Antwerp demonstrates conclusively that a true chemical action takes place, because the water, before it reached the iron, had undergone twelve hours' subsidence and ordinary filtration through 2 feet deep of sand, and must therefore have been deprived of all the mechanical suspended impurities which sand was capable of taking from it; and yet the remaining impurities, when acted on by the iron, were sufficient to cause the clogging up of a very open mixture of gravel and iron, much too coarse to act as a filter, and which, as a matter of fact, permitted the water to issue on the sand filters in the muddy condition which it must have acquired in passing through. The rate of filtration was not nearly so rapid as was expected from preliminary experiments. It was thought that the water could be purified at the rate of 150 gallons per square foot per twenty-four hours. In reality, however, the rate did not exceed half that amount. For small installations, and with fairly clean water, it would be safe to make the iron and sand filters each have an area of such extent as to filter at the rate of eighty gallons per square foot per twenty-four hours.

Mr. Anderson recommends that the water, as it comes from the iron filters, should be allowed to fall in a shallow cascade or a balloon jet into the sand filter, so as to bring as large a surface as possible into contact with the air; with some kinds of water it is a very difficult to remove a faint marshy taste and smell; in such cases, the blowing of a considerable volume of air through the water after treatment with iron, by means of perforated pipes, has been found beneficial, and the same method is efficacious in hastening the deposit of iron where there is not sufficient space to allow time for natural aeration. The depth over the sand should be such as to allow about four hours before the inflowing water reaches the sand. Thus, if the filtration be at the rate of 6 inches deep per hour, or 74½ gallons per square foot per twenty-four hours, the water over the sand should not be less than 2 feet deep. Over the filters the water assumes a a reddish hue, and a slimy deposit is left on the surface of the sand; this has to be removed from time to time in the usual manner the frequency depending on the purity of the water to be treated, and generally also on the season of the year. When a filter begins to run sluggishly, its life may be increased by about 25 per cent. by trailing a light chain over the surface of the sand, and by that means breaking up the slimy deposit.

The increased demand for water by the citizens of Antwerp brought about the process invented by the author (for illustration see ENGINEERING NEWS Sept. 5, 1885,) in which the water was treated by agitation instead of filtration. This purifying machine was practically an iron cylinder revolving slowly on its long axis on hollow trunnions; this cylinder was arranged inside with curved ledges or shelves fitted to scoop up the iron and shower it down again continuously through the water passing through the trunnions. One-tenth of the volume of the volume of the cylinder was filled with coarsely subdivided iron; either Prof. Bischof's, so called, spongy material, or iron cast into small bullets, or ordinary coarse cast-iron turnings from shops; the last form is found most efficient. The motion of the cylinder is very slow; those in Antwerp are 5 feet in diameter, 15 feet long, with 10 inches inlet and outlet pipes revolve once per minute and are capable of purifying 500 gallons per minute; one-third horse power will drive it.

The effects of the treatment of water by iron may be classed under three heads: (1) The invariable result is that the organic matter is altered in its chemical nature, and the albuminoid ammonia is reduced to from one-half to one-fifth of its original amount. (2) A reaction analogous to that in Clark's softening process appears, in many cases, to go on. The iron oxide which is produced, by combining with some of the carbonic acid which holds the carbonates of lime and magnesia in solution in the water, causes some precipitation of these to take place, and hence an appreciable amount of softening generally results. Thus, at Antwerp, the boilers of the pumping station were originally fed with untreated water, a hard scale was consequently formed in them; but when the arrangements were altered, and the treated and filtered water was supplied, the scale was greatly reduced in quantity and became a very open friable character, which does not adhere to the boiler plates. In the same way, when water contains much iron in solution, the treatment with iron causes a deposition of the metal on account of the removal of free carbonic acid, so that the waters of the Nethe have less iron in them after treatment than before. It is very remarkable how completely the iron is deposited from solution in this process; the merest trace only remains—an amount not greater than the Kent Company's water, for example contains. An idea prevails that because iron is used in purification, the water resulting must necessarily be unfit for many purposes, such as washing linen, paper making, and so on. I have not been able to find any grounds for this prejudice. Fish live and thrive in the water, it is used exclusively by the famous "Zoological Gardens" at Antwerp, aquaria are supplied with it, and no complaints about its injurious effect on linen have ever been received. (3) Treatment with iron appears to destroy or remove much of the infusiorial life. According to Dr. Frankland, Bischof, Voelcker, G. H. Ogston, and others, who have experimented in the laboratory, the treatment with iron prevents the development of that kind of microscopic life which is the cause of putrefaction of animal substances; and Mr. Ogsten's experiments with sterilized infusions placed in sterilized chambers, and also with Dr. Koch's method, prove that the microbes causing fermentation and putrefaction are destroyed or removed.

In the autumn of 1885 the unusual drought coupled with a greatly increased consumption due to the visitors to the International Exhibition, created so severe a demand on the purifying arrangements of the Water Company that the marshy taste could not be entirely obliterated. But though some alarms was occasioned because of the cholera raging in Spain, a commission of five eminent Belgian chemists found nothing aieterious in the

water, and it was absolutely sterile to Koch's gelatine tests.

This Anderson system is now in operation at Antwerp, Gonda and Dordrecht, in Holland, and at the extensive iron works of Messrs. Cail & Co., on the Seine, at Paris. Experimental apparatus of large size is also in operation in Berlin and at Ostend.

A table of analysis, showing the degree of purification attained, is appended:—

Effect of Purification by Iron.

	O'ganic matter		Ammonia.			
			Albumenoid		Free.	
	Before.	After.	Before.	After.	Before.	After.
Antwerp	77	31	.27	.08	.40	.00
Dordrecht	34	14	.14	.05	.12	.00
Gouda	151	85	.41	.23	.05	.03
Ostend (single purification)	135	76	.58	.22	1.30	.12
Ostend (double purification)	—	40	—	.19	—	.23
Paris	51	25	.16	.06	.40	.00

The cost of the process depends greatly on local conditions and the quality of the water. Where filters exist, Mr. Anderson puts the probable cost at $5,000 per million gallons per twenty-four hours. The working expenses are nominal, being merely the running of the cylinders, oiling, and once a week a fresh supply of iron. The cost of the Antwerp water delivered in the mains under a pressure due to 280 feet head does not exceed 1½ cents per thousand gallons for working expenses of all kinds.

The Value of Iron and Steel in England.

The Engineer, for December 10, 1886, makes some remarks upon the value of manufactured iron and steel in England. According to this journal the value of the manufactured iron trade in the North of England has been greatly impaired by the advance of the steel industry; for the present year the iron trade will figure about $6,700,000, an amount far below previous years. In 1885 the actual sum received for the manufactured iron made by the associated makers was certainly above $8,625,000; in 1884 this sum was at least $12,500,000, and in 1883, with the largest ship production on record, it was about $17,500,000.

The angles produced are not half the quantity of three years ago, and the quantity of plate sold has fallen in a similar manner. But as ship-plate sold over the first quarter of 1883 at $32.20 per ton on the average and now average only $21.83, this accounts in a manner for the falling off in values.

The Bessemer and Siemens steel trade, however, has a present value of about $7,500,000, counterbalancing to a certain extent the reduction in the iron products. *The Engineer* remarks that there is trouble ahead in the fact that iron was an English product in the raw state; but that while the world's demand for steel is increasing sufficient ores do not exist in England suitable for this convertion; it points out the importance of obtaining these ores as cheaply as possible and so still retaining the smelting, converting and working into structural forms of the newer material of construction.

PERSONAL.

H. F. KEITH is Chief Engineer of the Poughkeepsie & Southeastern R. R.

MR. TEMPLE is Chief Engineer of the Memphis & Nashville R. R., now being surveyed, with headquarters at Richmond, Va.

ARTHUR H. SCOTT, Assistant City Engineer, Milwaukee, Wis., has resigned to enter into partnership with his brother, a prominent architect, at Duluth, Minn. He will be succeeded by JOHN E. HATHAWAY.

F. E. HINCKLEY is General Manager of the Chicago & St. Louis R. R., from Chicago to Pekin, Ill., which has been purchased by the Atchison, Topeka & Santa Fé R. R. Co.

JACOB BLICKENSDERFER, Chief Engineer of the Union Pacific R. R., has been appointed Consulting Engineer to the company; V. G. BOGUE will succeed him as Chief Engineer.

J. CALDWELL has been appointed Superintendent of the Cairo, Vincennes & Chicago R. R., with office at Mount Carmel, Ill.; in place of J. M. GILL resigned.

COL. R. B. FRANK, of St. Louis, is the Chief Engineer in charge of the Texas extension of the Missouri R. R.

E. G. NOURSE, Chief Engineer of the Chicago, Evanston & Lake Superior R. R., has resigned to accept a position as engineer on the Atchison, Topeka & a Santa Fé R. R.

WM. HARVEY TWISS, bridge contractor, of Cortland, N. Y., died at that city on November 26th, at the age of forty-three. He was for several years eastern manager for the King Iron Bridge & Manufacturing Co.

JAMES H. LANCASTER, 187 Broadway, New York, has just completed the erection of one of the largest systems of fuel economizers in America at the sugar refineries of Messrs. Matthiessen & Wiechers, Jersey City, N. J. It consists of 768 pipes and their accessories, and involved an outlay of about $10,000.

NEW APPOINTMENTS in the Central R. R. of New Jersey, are as follows:

W. W. STEARNS has been appointed Superintendent of the New Jersey Central Division, and also of the ferries and boats connected therewith. His office will be at Elizabeth.

W. V. CLARK has been appointed Superintendent of the New Jersey Southern Division. His office will be at Long Branch.

G. W. TWINING has been appointed Superintendent of of the Lehigh and Susquehanna Division. His office will be at Mauch Chunk, Pa.

W. H. PEDDSE has been appointed Engineer of the New Jersey Central and New Jersey Southern Divisions. He will have charge of the maintenance of the roadway of all the lines in New Jersey, including buildings, stations, piers, bridges, docks and other structures. His office will be at Elizabeth.

J. H. THOMPSON has been appointed Engineer of the Lehigh and Susquehanna Division. He will have charge of the maintenance of the roadway on all the lines in Pennsylvania, including buildings, stations, bridges and other structures. His office will be at at Mauch Chunk, Pa.

James B. Francis.

(With Portrait.)

JAMES BICHENO FRANCIS, Past President of the American Society of Civil Engineers, was born at Southleigh, Oxfordshire, England, on May 18, 1815. In 1828 his father was appointed Superintendent of the Duffryn, Llynwi & Porth Cawl Railway and the harbor of Porth Cawl, in Glamorganshire, South Wales. This connection shaped the professional life of the son and in 1829, at the early age of 14, James B. Francis was employed on the harbor works of Porth Cawl under Mr. Alexander Nimmo, as chief engineer. In 1831 he was engaged in Devonshire and Somersetshire on the Grand Western Canal with Mr. James Green as his chief engineer.

Mr. Francis came to America in 1833, landing in New York on April 11. The times were favorable for civil engineers, the era of railroad building having actively set in in this country, and as a consequence the young English engineer very soon found employment as an assistant under Wm. Gibbs McNeil and George W. Whistler in the surveys for the New York, Providence & Boston Railroad.

In the next year (1834) Mr. Whistler was engaged in starting the building of locomotives in New England and took charge of the extensive hydraulic improvements upon which the city of Lowell was to depend for its commercial prosperity. Mr. Francis was associated with him in these enterprises, and when Mr. Whistler left Lowell in 1837 to take the position of chief engineer of the Western Railroad of Massachusetts, now part of the Boston & Albany Railroad, Mr. Francis remained at Lowell as chief engineer for the Proprietors of locks and canals on Merrimack river.

In 1845 he was appointed the agent of the company and continued in that capacity and as their chief engineer, until he was honorably retired from active duties in 1884, after fifty years service; and at the present time he is the consulting engineer in all important work connected with the hydraulic improvements of Lowell.

During this long and faitnful period of duty, Mr. Francis had under his personal charge all that pertained to the management of the water-power, and a prominent and delicate feature in this charge was the equitable distribution of power among the several companies according to their individual needs and rights. This service called for the execution of many original hydraulic experiments, on a scale that had hitherto never been attempted, in regard to the volumes of water measured. The principal results of this work have been given to the professional world in "Lowell Hydraulic Experiments," the first edition of which was published in 1855, and republished with additional data in 1868 and 1883. This work is a recognized authority among hydraulic engineers both in America and in Europe. Mr. Francis has been a frequent contributor to technical literature aside from his chief work; "The Strength of Cast-Iron Columns," published in 1865, being probably the next in importance.

Mr. Francis may be regarded as the founder of a new school of hydraulic engineers, by the inauguration of a system of experimental research which, through his patient and careful study, has reached a degree of precision before unknown. His experiments are marked by exactness from their very inception and his results now serve as data in themselves for further investigation. In gauging the flow of water, by weirs and floating tubes, the volumes treated by him have been unparalleled and he has reduced the possible error from the ten per cent. often allowed in previous experiments, to two per cent. or less.

Mr. James B. Francis was elected a member of the American Society of Civil Engineers on Nov. 5, 1852, and was the President of that Society from Nov. 3, 1880 until January 18, 1882.

Annual Meetings of Engineers and Surveyors.

The Eighth Annual Meeting of the *Ohio Society of Surveyors and Civil Engineers* will open in Columbus, O., on January 11th. Besides the usual reports and elections, seventeen papers will be read; time and space forbid fuller notice until next issue.

The *Michigan Engineering Society* will hold its Eighth Annual Convention at Grand Rapids, Mich., on January 25, 26 and 27.

The *Nebraska Association of Engineers and Surveyors* will hold its Fourth Annual Meeting at Lincoln, Neb., on January 17, 18 and 19. A largely attended and interesting meeting is expected.

Chinese Railroads.—A letter from Tientsin, dated October 28th, says that an experimental and diminutive French steam tram-way is in operation at that place. The French, English and Germans are moving heaven and earth to get control of Chinese railway building; but so far have only succeeded in killing each other off. Gen. Wilson, on the part of the Americans, is said to have made certain explorations and reports at the request of the highest Chinese authorities; he has established the most friendly relations with Li Hung Chang and other high officials; but as yet nothing definite has been secured by him.

Very truly yours
James B. Francis

CORRESPONDENCE.

Close Leveling.

KANSAS CITY, MO, December 21, 1886.

EDITOR ENGINEERING NEWS:

In an article on leveling in ENGINEERING NEWS for December 4th, the author mentions .02 as a low value for error in feet $\times \sqrt{\text{distance in miles}}$.

The writer, some years ago, ran nine circuits, making 143 miles altogether, with an ordinary 17-inch Heller & Brightly level, in all kinds of weather and over ground which was nearly all hilly and partly very abrupt, reading the rod, for the most part to hundredths, by open sights, with a resulting mean value of error in feet $\times \sqrt{\text{distance in miles}} = .0103$.

One hundred and forty-three miles is obviously too short a distance from which to deduce any general rule, but it is the writer's opinion that, with a *reliable instrument* and care in its use, the value of .02 is greater than the average should be where accuracy is an object.

Very truly, KAPPA.

Irrigation Laws.

BOISE CITY, December, 15, 1886.

EDITOR ENGINEERING NEWS:

In your review of December 4th, of Mr. Dorsey's paper on irrigation, read before the American Society of Civil Engineers, you say, "Mr. Dorsey had to acknowledge that while it was the law (allowing the entire appropriation of the water of a stream) in those sections it was likely to lead to much future litigation and trouble."

Permit me to say that Mr. Dorsey should have admitted nothing of the kind as the facts prove the contrary.

The laws of irrigation enacted by Colorado in 1881, are more arbitrary than any that have ever been passed in this country; nevertheless in three years time litigation had ceased. There was not a single case before the courts—Vide. Report of State Engineers—

The lawyers whose opinion Mr. Dorsey quotes are the very men who told him in my hearing that 'a case demanding riparian rights could not obtain in any court in those commonwealths." Referring to Arizona, New Mexico, Colorado, Utah, Idaho, Wyoming, Dakota, and Montana.

A letter of this kind must necessarily be brief, but I can furnish proof for the following statement if desirable.

No property in the above named commonwealths has proportionately less trouble from present litigation or less fear of future litigation than *water rights*'

Very respectfully,
A. D. FOOTE, Mem. Am. Soc. C. E.

[The remarks of Mr. Dorsey were quoted as understood by our reporter. This radical departure from the common law was so startling to the members of the Society present that many questions were asked the speaker, and his answers may have confused the reporter. We accept Mr. Foote's correction of our report. ED. ENG. NEWS.]

WATER.

JACKSON, TENN.—The city will have a complete system of sewerage, for which plans and specifications have been prepared by H. C. Lowrie, C. E., of Denver, Col.

PORT CHESTER, N. Y.—It is proposed to construct a sewerage system. The State legislature will be applied to for permission to issue bonds.

THE EAST ST. LOUIS SEWER CO. has been incorporated at Springfield, Ill., by R. E. Woodward, R. L. Miller and J. W. Moss. Capital stock, $140,000.

WASHINGTON HEIGHTS, ILL.—The subject of a complete system of sewerage and water-works is being agitated. The committee of citizens to make an estimate of cost is composed of R. C. Groins, G. W. Murray, E. W. Bennett, Daniel Barnard and R. P. Layton.

CORTLAND, N. Y.—The Cortland Water Co. has declined to name a price for which they would be willing to sell the works, plant and franchise. The citizens have voted to organize a board of water commissioners.

BOSTON, MASS.—The new high service works for the supply of a small portion of the West Roxbury district were completed and put in operation on December 23rd; they comprise two Knowles duplex pumping engines, of 300,000 gallons daily capacity each; about 4,000 feet of 12-inch force main and a wrought-iron reservoir 40 feet high and 24 feet diameter with a capacity of 130,000 gallons, located on the highest elevation within the city limits.

VICKSBURG, MISS.—Messrs. Samuel R. Bullock & Co., of New York City, have filed a $10,000 surety bond, which is endorsed by Dennis Long & Co., of Louisville, Ky. The bond has been accepted and work will be commenced very soon.

WATER COMPANIES.—The Grassy Island Water Co. has been incorporated at Scranton, Pa., by Isaac P. Hand, of WilkesBarre. Capital stock, $5,000

The Oxford Water Co., of Oxford, Mass, is to be incorporated to give the city a water supply system.

REPORT OF THE CITY ENGINEER OF MANCHESTER, N. H.—W. H. Bennett, city engineer, has issued his annual report. During the year 21.87 miles of streets, street lines, etc, have been surveyed; 35.97 miles leveled, and 16.36 miles of grades set. The Webster street sewer has 300 feet yet to be built and the total cost will be $28,000; of the Bridge street sewer 1,500 feet have been built, the cost to date has been $19,193.73, an excess of $193.73 over the appropriation; of the South Main street sewer, 100 feet have been built, 900 yet remaining, 85 feet of which will be through the solid ledge. Mr. Bennett urges improved sewerage accommodation for several portions of the city and suburbs. Sundry bridge repairs have been carried out. The following is a summary of the work done in the districts including the city proper, West and South Manchester: Block paving relaid, 300 square yards; cobble paving laid, 4971.5 yards; cobble edging, 10,272 feet; brick sewers, 24x36 inches, 3,899 feet; Akron pipe sewers, 15-inch, 1,481 feet; 12-inch, 2,031 feet; 10-inch, 4,267 feet; 8-inch, 1,518 feet; sewers relaid, 145 feet; total sewers built, 13,341 feet, or 2.53 miles; macadamized roads built, 8,904 square yards; top-dressed, 11,920 square yards; total, 20,824 square yards; total number of manholes built, 20; lampholes, 4; cesspools, 76; edgestone reset, 1,808 feet; amount of streets graveled, 32,765 feet.

WATER PIPE CHARGES.—At Philadelphia, Pa., there has been some discussion as to the right of the city to charge for pipe laid in a private street. Mrs. M. H. Bedford owns a lot at Thirty-eighth and Centre streets, and had water pipes laid in front of the properties on those streets, paying $1 per foot. She recently opened a street called Charles Terrace in the same neighborhood, built several houses and laid water pipes in front of them at her own expense. The street was too narrow to be accepted by the city as a public thoroughfare, and therefore was not dedicated. The owner having laid the pipe at her own expense, wants to pay the usual water rent, but refuses to entertain the claim of the city for $1 per foot of pipe.

The ordinance of January, 1855, says that parties must pay $1 a foot for all pipe laid on streets in the city limits. The City Solicitor says: In the present case the owner has paid for pipe laid in front of her properties on Thirty-eighth and Centre streets, which are public streets. The city has been at no expense in relation to any pipe in Charles Terrace, and has not laid any, and therefore, has no right to make any charge. If under the existing ordinances the owner of property on Charles Terrace is entitled to use water, the charges should be for use of water and not for pipe, because the city has supplied no pipe on Charles Terrace."

NEW WATER-WORKS.—Castroville, Tex. Joseph Courand proposes to erect works, and has applied to the city authorities for permission to lay pipes.—Gadsden, Ala. The works have been purchased by Frank T. Redwood and Basil B. Gordon, who will carry out improvements.—Attleboro, Mass. An increased water supply is to be obtained; a reservoir with a capacity of 2,000,000 will be built and pumping engines put in; work will commence in the spring.—Sing Sing, N. Y. The water board has abandoned the idea of building the works, and is willing to enter into a contract with some company to take the water from Croton river and stand the chance of a fight with New York over the rights.—Kearney, N. J. As the township has not paid its State and county tax for 1877 it cannot issue bonds for water-works.—Milford, Mass. The citizens are considering the purchase of the town water-works for $390,000.—Hempstead, L. I. A project is on foot to supply the town with water from wells; John Gamble is interested.—Garnett, Kan. The Ohio Water-Works Co. has made a proposition to put in works, the town to pay $2,500 annually for fifty years.—St. Louis, Mo. Considerable extensions of the mains are to be undertaken.—Eureka, Ill. The water mains have been laid.—Cuero, Tex. Water-works are to be built soon; it is not yet decided by whom, but a stock company will probably be organized for the purpose.—Grand Rapids, Mich. The city has voted against issuing $5.0,000 bonds for improving the water supply system: it is now proposed to sell the works to a company.—Babylon, Bay Shore, and Islip, L. I. Negotiations are in progress for the construction of a joint system of water supply; a water tower 100 feet high would be erected between Babylon and Bay Shore, and eight miles of mains will be laid; the proposition has been made by John Lockwood, of New York City.—Richmond, Me. The new works are now in successful operation.—Avondale, O.. A system of water-works will be erected at a cost of $69,000; Col. Arthur G. Moore is superintendent.—Holdrege, Neb.—Fort Scott, Paola, Burlington and Ottawa, Kan.

STREET PAVING IN PLAINFIELD, N. J.—During the past year 3.75 miles of streets have been macadamized at a cost of about fifty cents per running foot of 16 feet width and 4 inches thickness of durable stone roadbed. One secret of this light expense has been in using a small quantity of broken stone, packed well with coarse sand, instead of dirt, for which the city has paid carting only. The total expenditure for the year, under direction of the Street Committee, is as follows: $10,000 for stone used and spreading same; $800 for Belgian blocks and laying; $2,500 for general work on street; Farragut avenue drain, $165; crosswalks, $428.32; tools, $70; engineer's services, $179; street commissioner's salary, $275, making a total of $14,377.32. Taken in connection with the permanent work done in the past years there is now a total length of about 12.75 miles of good substantial hard roadway. Of this amount 41,000 lineal feet have been covered with broken stone at least 4 inches deep and 16 feet wide, and 26,250 feet of macadamized roadbed.

MEMPHIS, TENN.—Owing to the city legislative council having decided that the city should build works, the Memphis Water Co. has been unable to consummate the sale of the plant to Samuel R. Bullock & Co., of New York City. It is probable they will make another proposition to the city. There is very divided opinion, but the general idea is that the city will not erect its own works. A proposition to erect water-works for the city has been made by Messrs. Turner, Dillaway & Rawson, of Boston, Mass., at terms considerably below any offer yet made. It will receive careful consideration.

WATER PURIFICATION.—Dr. Albert R. Leeds lectured at the Franklin Institute, Philadelphia, December 23rd, on the purification of the water supply. In 1883 he constructed an apparatus for aerating ill-smelling water from the Schuylkill dam, and found that the bad taste and smell had departed after treatment. He thought the filtration by sand, the only efficient means of filtration, too inconvenient and expensive to be adopted in this country, though used with success in England. The lecturer concluded by saying that it was vicious to use Schuylkill water for drinking purposes when pure water might be had from the upper Delaware, but until the waste of water, one-half of the supply, was largely reduced by some provisional measure, it was not probable that the water would be drawn from the purer source.

A CITY SURVEYOR'S AUTHORITY.—The Sewer Committee, of Newark, N. J., held a meeting recently to consider the question of the alleged inferior stone used in the construction of a sewer. Mr. Adam, City Surveyor, stated that he had given permission for oblong trap rock blocks to be used instead of granite, after satisfying himself that, when properly trimmed, they were equal to the stone called for in the contract. No property owners could object as the sewer runs through propert owned by the aqueduct board. It was put in evidence that while the granite blocks cost Messrs. Shanley, the contractors, $1.32 per square yard, or $57.39 per thousand, those actually finished cost $59 per thousand at the Rocky Hill quarry, and $63 delivered at Newark; an experienced stone dealer stated that the stone was superior to granite. Engineer James B. Owen, who is employed by the county stated that in his opinion the City Surveyor was perfectly justified in making the change, as a prerogative that every surveyor ought to have. The change was made to hasten the completion of the work. The following resolutions were adopted: "That from the evidence it appears that for a portion of the work a change of stone was made by the authority of the City Surveyor; that as now appears no injury was inflicted upon the city by the change made, and that the contractors made nothing by the change, but that the substituted material was more expensive and equally good for the purpose.

Second, That the question of the authority of the City Surveyor to make a change under such conditions be referred to the City Council for his opinion as a question of law."

THE BELFAST WATER-WORKS.—A contract has just been let for $175,000, for the construction of water-works for Belfast, Ireland. This includes the building of a conduit seven and one-half miles long, and a service reservoir, the conduit for 12,000 yards is 3 feet in internal diameter made of radiating, moulded bricks, in two rings, 6¼ inches total thickness where the covering does not exceed 10 feet in depth, and 9 inches thick when this exceeds 10 feet. This conduit must be perfectly water-tight, and to insure this, the specification requires a joint of hair-felt to be carried around the conduit between the two rings of brick, and well tarred before being put in place. Where cast-iron pipes are substituted for brickwork, these are 27-in. in diameter laid in the proportion of three-fourths "turned and bored" and one-fourth lead joints. The service re-

servoir will be four and one-half miles, from Belfast made by damming a deep valley, this embankment will have a maximum height of 60 feet, will be 12 feet wide on top and have slopes of two and one-half to one with a length of 500 feet; it will have the usual puddle trench and walls and require 60,000 cubic yards of filling. The water before entering the town will pass through pitch pine box screens with copper-gauze, filled with cinders. These works include in all about 8,800 cubic yards brickwork in cement mortar, 4,100 cubic yards concrete 900 cubic yards masonry in cement, 1,160 cubic feet ashlar-stone, 600 tons cast-iron, 20 tons wrought-iron, and filling, pitching reservoir lining, fencing, etc.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

Cable Railroad.—It is proposed to construct a cable railroad between Lansingburg and Troy, N. Y.; work is to be commenced in the spring.

The Manufacturers' Bridge Co. has been incorporated at Marseilles, Ill., by John F. Clark and others. Capital stock, $10,000.

Steel Ties.—The North Eastern R. R. Co. (of England) has placed an order for 10,000 steel ties with Bolckow, Vaughan & Co., and it is probable that other orders will follow: The experiments already made on this line have been entirely satisfactory.

The Northern R. R. of France, has let a contract for 10,000 tons of metallic ties of the Severac type.

Traction Engines for the Catskills.—It is reported that Mr. Rust, of Ithaca, N. Y., is building several traction engines specially designed for operating regular lines of passenger and freight traffic in the Catskill mountains; and for running excursion and special lines during the season. The routes at present mentioned are from Cairo to Windham, from Palenville to the Catskill Mountain House, and from Hobert (on the Ulster & Delaware R. R.) to Windham.

The Simplon Tunnel.—The International Commission has rejected the proposals of Feil, Agudio and Cail and has recommended a tunnel of either 12.4 or 10 miles in length. The larger one is preferred for every reason except that of cost, about $13,000,000 for a single track and about $16,000,000 for a double track. The shorter tunnel, commencing at an elevation of about 2,590 feet, is considered the most feasible, the cost of construction being about $10,000,000 for a single track and $12,000,000 for a double track. In this estimate is included $485,000 for lines of approach and $400,000 for reducing the temperature of the tunnel during construction.

Brooklyn Bridge.—The committee on mechanical arrangements have reported that after examining 112 designs and plans they are of opinion that the grip now in use, invented by Col. Paine and improved by Mr. Martin, is far superior in point of efficiency, and has proved itself durable and economical. They also reported that they had considered various plans for terminal arrangements, but as most of them involved switching by gravity, and as locomotives would be necessary in any case, for shifting the cars, they did not consider any change from the present plan desirable or necessary. The structure on the Brooklyn side will be extended to Nassau street and the permanent terminus will be at the corner of Nassau and Washington streets. The projected elevated railroads will connect with the bridge tracks at Nassau street.

New Bridges.—Mr. John Bair, of York Furnace, Pa., is the projector of the York Furnace bridge; a survey and map of the proposed site have been made and a company will be organized to carry out the scheme.——An iron bridge is to be constructed over the Champlain canal at Cohoes, N. Y.; address Superintendent of Public Works, Shanahan.——A new bridge will be built at Mount Vernon, Ind., by the Louisville & Nashville R. R.——A bridge will be erected across Salt Lick creek at Great Bend, Pa., by the county commissioners.——A bridge will be erected across the Flint river, near Albany, Ga., by the county commissioners.——An iron bridge is to be built across the Potomac river, at Williamsport, Md., by citizens of Washington county, Md., and Berkeley county, Pa.; estimated cost, $25,000.——The King Iron Bridge & Manufacturing Co. is constructing an iron bridge across the Lackawanna river at Old Forge, Pa., for the county commissioners.——A bridge is to be built across the Mississippi river at Minneapolis, Minn.; the city engineer's plans and estimates to be adopted and $100,000 bonds will be issued.——The Piedmont & Cumberland R. R. Co. will erect a bridge over the Chesapeake & Ohio canal at Annapolis, Md.——A highway bridge is to be built at Ithaca, N. Y., from Barnum island to Long Beach; three 150 feet spans and a 50 feet draw span; F. H. Irving is interested.——A bridge is to be built across the Missouri river between Council Bluffs and Omaha; it will be for road, railroad, street cars and pedestrians.——A stone viaduct is to be built across the railroad tracks at Western avenue and Kinzie street, Chicago: Mr. Artingstall, city engineer, estimates the cost at $193,000, including approaches, $114,600, arch spans, $13,500, improvements, $65,000; the railroads will pay two-thirds of the cost.——The U. S. Senate has passed bills authorizing the construction of bridges across the Mississippi at Memphis, Tenn., and across the Cumberland river at Nashville, Tenn.——The Long Island R. R. Co. will erect a new drawbridge across Flushing creek.——At Chicago, Ill., the city engineer is inquiring into the cost and feasibility of constructing a bridge at 14th street.

Competitive Bridge Designs.—The Bureau of Construction of the Belle Isle bridge, Detroit, Mich., has recommended that competitive plans for the bridge be asked from various companies; and that the plans be examined by a committee of expert bridge engineers. The premiums are to be $700, $300, $250. It is probable that this course will be adopted.

Mississippi Bridge.—Mr. Duarea, of New York City, who has been making the surveys for the new bridge at Memphis, Tenn., reports that he has found on the Arkansas side at a depth of 125 feet a stratum of clay that will furnish a safe foundation. Engineers have hitherto expressed doubts as to the possibility of securing a foundation on that side of the river except at great expense, owing to the alluvial nature of the soil.

Railroad Surveys.—Versailles & Midland R. R. Engineers have started to locate the line for the extension from Versailles, Ky., to Lawrenceburg.——Missouri Pacific R. R. Surveys have been made for the extension from Jefferson City to Sedalia, Mo.——Ohio & Mississippi R. R. A line is being surveyed from Tunnelton to Bedford, it will be built by the Indiana Stone Co. to open up their quarries.——Norfolk & Western R. R. A line is being surveyed from Petersburg to the granite quarries in Dinwiddie county, Va.; another line is being surveyed from Mercer county, W. Va., to Ashton, on the Ohio river, where connection will be made with the Ohio River R. R.——Memphis & Nashville R. R. The surveys are being made by the engineers of the Virginia Construction Co; Mr. Leake is the manager of the construction company.——Atchison, Topeka & Santa Fé R. R. The surveys are being made for the line from Kansas City to Chicago; the Chicago & St. Louis R. R. has been purchased, and from Streator, Ill., the line will run to Fort Madison, Ia., via Galesburg.

New Railroads and Extensions.—Baltimore & Ohio R. R. It is said that it is proposed to acquire the South Penna. R. R.——New York, Susquehanna & Western R. R. The line will be double tracked from Jersey City to Paterson.——Chicago & Northwestern R. R. A number of branches will be built in Nebraska and Dakota under the new incorporation of the Fremont, Elkhorn & Missouri Valley R. R. Co., the capital stock of which has been raised to $30,000,000.——Kansas, Texas & Southwestern R. R. Construction has commenced at Garden City, Kan.——Aberdeen, Fergus Falls & Pierre R. R. The line has been completed to Aberdeen, Dak.——Ohio & Mississippi R. R. A line will be built from Vincennes to Louisville; W. W. Peabody, general manager, Cincinnati, O.——Wilmington & Weldon R. R. The line will be extended to Lucknow or Fayetteville, N. C.——Old Colony R. R. A line is to be built from Tiverton to Seaconnet.——Iowa, Burlington & Northwestern R. R. This extension of the C. R. I. & P. R. R. will be finished in the spring from Watertown, Dak., to Aberdeen——Poughkeepsie & Southeastern R. R. This line will be built shortly from Poughkeepsie, N. Y., to Hopewell, where it will connect with the N. Y. & N. E. R. R.

Another East River Bridge.—A bill has been brought before the State Legislature making provisions for the construction of a bridge across the East river between New York and Long Island City, to be constructed in accordance with the act incorporating the Long Island Bridge Co., and under the supervision of the United States Corps of Engineers. The bridge will be on the cantilever principle, and has been designed by Mr. C. C. Schneider, New York City; it will be 155 feet above the water and has been designed for heavy railroad traffic; the cost is estimated at about $7,000,000. It will start from 80th street, New York, and will have a pier on Blackwell's island. The Long Island R. R. Co., N. Y. C. & H. R. R. R. Co., and the Manhattan Elevated R. R. Co. are strongly in favor of the new bridge. It will be used for through freight traffic as well as for the heavy local passenger traffic it would receive, and a branch line will be built to reach the large riverside manufactories of Brooklyn; the trains will run from the Grand Central Depot to Long Island City. Work must be commenced by May 13, 1888.

The Cascade Tunnel and Switch-Back.—Nelson Bennett, contractor for the tunnel on the Cascade division of the Northern Pacific R. R., states that 2,750 feet have been driven, 1,360 at the east end and 1,390 at the west end; this leaves 2,090 feet still to be driven. Work on the switch-back over the mountains and on the grading for the track east and west of the tunnel is progressing rapidly; cars will be running over the switch-back by March or April.

New Railroad Companies.—Kansas, Colorado & California R. R. Co.; from Ellsworth county to the western State line in Hamilton county, where it will connect with a line to be built by the same parties from Colorado to Albuquerque, N. M.; length of road, 600 miles; headquarters at Coolidge, Kan.; stock $10,000,000.——Mount Vernon & Uniontown R. R. Co., in Indiana, 14 miles long; Sylvester Pike, G. V. Menzies and others; capital stock $70 000.——Fremont, Elkhorn & Missouri Valley R. R. Co. (Branch Line No. 5); to build to Hastings, Neb.; capital stock $3,000,000.——Atlantic, Birmingham & Great Western R. R. Co.; from Brunswick to Montezuma and La Grange; James H. Fanning, R. W. Clements, J. G. Truitt and others; capital stock, $10,000,000.——Kansas, Nebraska & Minnesota R. R. Co.; from Duluth, Minn., to Cheyenne county, Kan.; A. J. Hersington, S. H. Carr, and others, of Larkin, Kan.; office at Larkin; capital stock, $26,000,000.——St. Louis, Indianapolis & Western R. R. Co.; a link in a new route from St. Louis to Cleveland; capital stock, $40,000,000.——Carbondale & Carterville R. R. Co.; between the places named, in Illinois; W. W. Barr, of Carbondale, and others; capital stock, $200,000.

Mexican Railroads.—The concession for a railroad from Potrero to Cedral, in San Luis Potosi, which had expired, has been renewed and extended, and has been transferred to Diez Gutierrez.——John E. Early, resident representative of the Mexican Central R. R. Co., at Tepic, has received orders to take up all the material which was employed on the part of the branch road which was to unite Tepic with San Blas, and which it was the original plan of the railroad company to continue to the city of Guadalajara. The branch had only reached the town of Huaristemba, on its way to Tepic. On the receipt of the news that the rails, etc., were to be removed, there was some excitement at Tepic, and the house of Barron Forbes & Co. called a meeting of the local merchants, and action was taken looking to securing the aid of the town government in preventing the destruction of the railroad. There was some talk of subsidizing the company at the rate of $300 per mile or to build the branch at the expense of the local merchants.——Government engineers have recommended retaining walls and other improvements to promote safe transit on the line through the Tajo of Nochistongo. The wooden gutters carrying off the surplus rainwater from the top of the Tajo need to be carried out farther so as to prevent washing away the side of the cut where the railroad runs. It is proposed to move the track farther inward wherever there is sufficient space to allow of the alteration.——The Mexican Central R. R. Co. has received permission from the government to contract with other companies for the construction of the Pacific lines and from Aguascalientes to San Luis Potosi and Tampico; the construction to be carried out under the concession to the main company, which may acquire them after completion. The company will be responsible for the completion of the lines.

Proposals Open.

Cement, Stone, Etc.—Cement, broken stone, sand, dressing granite, timber, iron, etc., for repairs to stone dry dock in the Brooklyn Navy Yard. Navy Pay Office, 27 State street, New York City. January 4.

Court House.—Estimated cost, $12,000. Wm. Carr, Mayor, Roanoke, Va. January 4.

Lamp Posts.—Iron lamp posts, supports and lamps. Board of Improvements, Cleveland, O. January 5.

Boilers.—Three 60-inch horizontal tubular boilers. W. B. Shockley, Treasurer, National Home, Leavenworth, Kan. January 5.

Sewers.—Enlarging sewers. James Shanahan Superintendent of Public Works, Albany, N. Y. January 6.

Lumber.—White pine and boards. Navy Pay Office, 27 State Street, New York City. January 7.

Submerged Pipes.—Furnishing, dredging and laying 1,100 feet of 16-inch water pipe across the Mississippi; 175 pounds per foot; flexible joints every 27 feet; 5 expansion joints. Work to be completed by September. Board of Water Commissioners, St. Paul, Minn. Jan. 7.

Pipe and Fittings.—2210 tons of cast iron pipe from ¾-inch to 20 inch diameter, cast-iron fittings, brass stops and ferrules, special castings of brass and iron; lumber and jute packing. The Water Board, Baltimore, Md. January 10

Railroad.—Cape Breton R. R.—the section from Grand Narrows to Sydney. Plans and specifications at the office of the Chief Engineer of Government Railroads, Ottawa; and at the office of the railroad at Port Hawkesbury, C. B. A. P. Bradley, Secretary of the Department of Railroads and Canals, Ottawa, Canada. January 12.

Water Pipe.—200 tons of cast-iron water pipe. Wm. McKenzie Reeve. Morrisburg, Canada. January 15.

Steamer.—Twin-screw steamer "Zizania." Office of the Light-House Board, Washington, D. C. January 17.

Street Work—Grading, curbing, crossings, flagging, guttering, macadamizing, culverts, drains and retaining walls. Board of Public Affairs, Cincinnati, O. January 19.

Dredging.—In' Wilmington harbor, Del., and ice harbor at New Castle, Del. Wm. F. Smith, U. S Engineer Office, Wilmington, Del. January 22.

River Improvement.—Dredging, rock excavation, matiress dykes and jetties for improving the James river. Lieut. Col. Wm. P. Craighill, U. S. Engineer Office, Richmond, Va. January 26.

Contracting.

City Hall.—Plans have been drawn by Architect Samuel Hannaford, Cincinnati, O., for a new City Hall in that city; 180X176 feet; estimated cost about $700,000.

Warehouse.—Messrs D. M. Ferry & Co., of Detroit, Mich., whose warehouse was recently destroyed by fire will rebuild at once at a cost of $130,000.

Blowing Engines.—The contract for twelve blowing engines for the new furnaces of the Pratt Coal & Iron Co., Birmingham, Ala., has been awarded to the Weimer Machine Works Co., of Lebanon, Pa.

Water Pipe and Hydrants.—The Water Commissioners of Turner's Falls, Mass., have awarded the contract for laying the mains to Charles H. Egbee, of Flushing, N. Y., for $13,447; the Ludlow Valve Manufacturing Co., of Troy, N. Y., will furnish and place the 7-inch hydrants, with valves and two couplings, for $30 each.

Court House.—Architects E. E. Myers & Son, Detroit, Mich., have designed the new court house for San Joaquin county, at Stockton, Cal., which will cost about $200,000. Sealed proposals will be received for same until February 9, 1887, at the office of the County Clerk, Stockton, Cal., accompanied by a certified check for $5,000. C. W. Yolland, County clerk.

Machinery.—Messrs. E. P. Allis & Co., Milwaukee, Wis., are building some very large machines; among them two stamp mills, or ore crushers, for the Tamarack Iron Mining Co., each of which, when in working order, will weigh seventy-five tons. The anvil blocks weigh twenty-eight tons, and the crushing hammers twelve tons each.

Raising Railroad Track.—The Texas & Pacific R. R. Co., has awarded a contract to S. B. Knowlton & Co. of Plaquemine, La., for raising the road bed of the line for a distance of 16 miles west of the Atchafalaya river, to keep the track above floods. A trestle 5,000 feet long will be constructed so as to leave an outlet for the water. The contract amounts to $182,000.

Railroad Buildings.—The West Jersey R. R. Co. will erect a large repair shop in Gloucester City, N. J.

The passenger depot and train shed of the N. Y. L. E. & W. R. R. at Jersey City, N. J., will cost $75,000 each; the depot will certain offices, baggage and express rooms, restaurant, emigrants waiting room and a general waiting room 66 by 100 feet; the train shed will be 140 by 160 feet. The company is removing its shops from Salamanca to Hornellsville, N. Y.

City Work.—At New Orleans, La., the following prices have been bid: granite block paving, laid on sand and joints filled with sand and gravel, $5.50 per square yard; North river blue stone curbing, 4 inches thick, 83 cents per square yard; Trinidad asphalt paving, 2.5 inches thick on a 6 inch bed of concrete, $3.50 per square yard; asphalt paving on sidewalk, 1 inch thick on a 3 inch bed of concrete, $1.50; Shillinger pavement for sidewalks, $2 or $2.25 accerding to the locality; German flagging for sidewalks, $2; brick sidewalks grouted with cement, $1.25; iron plates, 1.25 inch thick, are placed over the drains at each street intersection, they cost on an average 4.50 cents per pound or $9.10 for each intersection.

The following proposals were opened at the Department of Public Works, New York City, December 30: (1) Regulating and granite block paving on 73rd street from avenue A to 1st avenue; J. B. Devlin, $7,620.16; George F. Doak, $7,693.77; W. J. Clark, $9,011.20; Charles Guidet, $10,086.20. (2) Regulating, grading, curbing and flagging on 142nd street, from 7th to 8th avenue; the bidders were B. Mahon, W. J. Clark, Leeson & Carr, C. Warmken; the figures were not verified but it appears that the bid of C. Warmken is the lowest. (3) Furnishing and delivering cut stone at the reservoir, High bridge, 8,000 cubic feet of rock faced ashlar and 1,600 linear feet of granite coping; B. Mahon, $20,560; Charles Guidet, $21,768.

Gas and Electric Lighting.—The following proposals for illuminating the streets and public buildings for 1887 have been received at the Department of City Works, Brooklyn, N. Y.: Citizens' Gas Light Co., $22 per lamp per annum; for public buildings, $1.75 per 1,000 cubic feet. Brooklyn Gas Light Co., $19.80, $1.50. Nassau Gas Light Co., $22, $1.75. Metropolitan Gas Light Co., $22, $1.75. Peoples' Gas Light Co., $22, $1.75. Williamsburg Gas Light Co., $21.75, $1.75. Municipal Electric Light Co., $182.50 per light per annum. Citizens Electric Illuminating Co., $182.50 per light per annum.

Street Paving.—The following bids have been received at Baltimore, Md.; Patrick Reddington, grading, 35 cents per cubic yard; curbing, 40 cents per lineal foot; paving 5.5 cents per square foot; A Snyder & Sons, 40, 40 and 6 cents; James T. McGovern, 37.5, 45 and 6 cents; Wm. E. Anderson, 47, 40 and 5.5 cents.

A Sub-Contractor's Claim.—A test case is to be tried in Indiana to settle the question whether a subcontractor can make a claim upon the person letting the contract, if the contractor, when paid, does not pay the sub-contractor. The case relates to the building of a house, the contractor was paid in full but did not settle with the sub-contractor, who now makes a claim against the owner of the building.

Excavation.—The following proposals have been received by the commissioners of Water-Works, Sandusky, O., for digging the trenches and constructing the valve vaults for the extension of the mains from the Infirmary to the Soldiers' Home: Price & Higgins, trenching, 4.5 cents; valve vaults, $10.25; James Conley, 4.75 cents, $13; Patrick Martin, 6 cents, $12.50; Schultz & Schieber, 9 cents, $14; McKeen & Callan, 9.75 cents, $9.50; Miles Cassidy, trenching only, 6.5 cents.

The City Comptroller of New Orleans, La., has received the following bids for excavating the Toulouse canal: Robert J. Connolly, $1.37½ per lineal foot; J. W. McDonald, $7,750 for the entire work.

Masonry.—The following proposals for the masonry for the court-house at New Albany, Ind., have been received by the Supervising Architect, Treasury Department, Washington, D.C.: Wm. S. Burns, Washington, blue Amherst, $29,987; buff Amherst, $31,800, Doerschbach & Decker, Sandusky, O., blue Berea, $30,404, buff Amherst, $33,366. E. F. Goebel, Chicago, Ill., Ohio blue stone, $39,937, Bedford limestone, $43,185. Blatz & Krebbs, Louisville, Ky., dark Bedford, $41,649. Crumbs & Melcher, New Albany, Ind., Bedford limestone, $31,700; Salem limestone, $32,000. Terre Haute Stone Works, Bedford stone, $32,324. Anderson Bros., Fremont, O., blue Amherst, $27,814; buff Amherst, $28,219; Bedford, $31,114. Peters & Melcher Steam Stone Works, Louisville, Ky., Bedford stone $35,675. Duminell Bros., Louisville, Ky., $32,206. Rice & Bassett, Chicago, blue Amherst, $34,000; buff Amherst, $35,802; Indiana limestone, $37,545. J. H. Caster, Baltimore, Md., Salem limestone, $52,236.

Water Pipe.—The following proposals have been received by the Water Works Trustees of Franklin, O.:

Pipe and Specials.—Cincinnati & Newport Iron and Pipe Co., bell and spigot pipe, $30.25 per ton (556.96 tons); specials, 1.7 cents per pound (26,030 pounds); flange pipe, 3.25 cents per pound (14,076 pounds). Ohio Pipe Co. Columbus, O., $31.50, 3.25 cents, 5 cents. Water & Gas Works Construction Co., Pittsburg, Pa., $33.50, 2.97 cents, 5.87 cents. Dennis Long & Co., Louisville, Ky., $33.50, 3.25 cents. A. H. McNeal, Burlington, N. J., $33.80, 2.70 cents. Lake Shore Foundry Co., Cleveland, O., $34.65, 3 cents, 7 cents. Builders' Iron & Foundry Co., 2.305 cents for specials. I. S. Cassin & Co., Philadelphia, Pa., 2.60 cents for specials.

Pipe Laying.—(4,350 feet of 10-inch, 6,675 feet of 8-inch, 8,595 feet of 6-inch, 13,829.5 feet of 4-inch pipe; including the setting of specials, hydrants and valves): Water & Gas Works Construction Co., Pittsburg, Pa., $6,061.08; Snyder & Williams, Dayton, O., $6,136.27; J. E. McGrath, Liberty, Va., $6,234.58; C. L. Vandergrift, Lynchburg, Va., $6,316.49; L. B. Stanley, Collingwood, O., $6,389.07; R. B. Caruthers, Newport, Ky., $6,602.82; Merigold & Miller, Lima, O., $6,911.15; Francis Leonard, Norwalk, O., $7,956.50.

Stop Valves.—(8 10-inch, 8 8-inch, 13 6-inch, 15 4-inch): Cincinnati Lead Pipe & Sheet Lead Works, $633.25; Crane Bros., Chicago, (Kennedy valve) $644, (Peet valve) $624.21, (Chapman valve) $545.56; Frontier Iron & Brass Works, Detroit, Mich., $660.50; Bourbon Copper & Brass Works, Cincinnati, O., $674.35; Kirkup & Son, Cincinnati, $675.25; Galvin Iron & Brass Works, Detroit, $675.25; Eddy Valve Co., Watertown, N. Y., $650.85; I. S. Cassin & Co., Philadelphia, $707.95; Chapman Valve Co., Indian Orchard, Mass., $728.67; Holly Manufacturing Co., Lockport, N. Y., $742.50; Ludlow Valve Co., Troy, N. Y., $749.65; R. D. Wood & Co., Philadelphia, $776; Whittier Machine Co., Boston, $786.90; Water & Gas Works Construction Co., Pittsburg, $853.28.

Fire Hydrants.—(60 double nozzle hydrants): Bourbon Copper and Brass Works, $1,620 and $1,440 (with frost case), $1,200 (without frost case); Whittier Machine Co., $1,635, $1,410; I. S. Cassin & Co., $1,689, $1,425; Frontier Iron & Brass Works, $1,650, $1,440; Chapman Valve Co., $1,635.60, $1,448.40; Ludlow Valve Co., $1,650, $1,452. Kirkup & Son, $1,462.20 (without frost case); Galvin Iron & Brass Works, $1,462.20 (without frost case); Crane Bros., $1,575, $1,485; Eddy Valve Co., $1,710, $1,500; Water & Gas Works Construction Co., $1,767, $1,527; Holly Manufacturing Co., $1,740, $1,560; Whittier Machine Co., $1,950, $1,665; R. D. Wood & Co., $1,695 (with frost case).

Stop Boxes.—(44): Ludlow Valve Co., $122.32; Water & Gas Works Construction Co., $130.68; Kirkup & Sons, $132; Galvin Bros., $132; R. D. Wood & Co., $132; Eddy Valve Co., $132; I. S. Cassin & Co., $242.

Building.—The contract for the construction of the chamber of commerce at Cincinnati, O., has been awarded to Norcross & Co., of Worcester, Mass., for $524,000; Worcester granite to be used. The foundations and carving will bring the total cost up to $600,000.

Gas Works.—Messrs. Solomon & Co., of Louisville Ky., have been awarded the contract to light with gas the city of Winchester, Ky., the works to be in operation within twelve months.

Repairing Piers and Bulkheads.—The following proposals were opened December 27th, at the Department of Docks, New York City: For repairing pier at 152nd street, North river: John Dunn, $5,800; John Kelly, $5,889; Barth Cronin, 138 Luqueer street, Brooklyn, $7,400; Joseph Walsh, $8,200; John Gillies, $8,500; James D Leary, 73 William street, $8,948.

For repairing bulkhead between piers 18 and 19, East river; Feenan & Jenks, $2,000; James D. Leary, $2,390; Joseph Walsh, $2,500; Barth Cronin, $3,000; John Gillies, $3,500.

Street Work. The following proposal has been received by the City Engineer, Erie, Pa.: A. L. Barber Paving Co., asphalt paving, $3 per square yard, including grading, foundation, curbing, etc.; 9-inch pipe, 70 cents per lineal foot; 12-inch pipe, 90 cents; catch basins, $40 each; manholes, $50 each; landmarks protected, $5 each; 6-inch house connection pipes, 50 cents per lineal foot.

Jails.—The contract for the jail at Rosendale, Miss., has been awarded to F. B. Hull, of Jackson, Miss., at $13,000.

At Roanoke, Va., a new city jail, has been completed at a cost of $8,500, and proposals are being received for a court-house.

At Scranton, Pa., the new jail, which cost about $121,000, has been accepted from the contractor, Conrad Schreider.

Water Works.—The contract for the water-works at Emporium, Pa., has been awarded to R. D. Wood & Co., of Philadelphia.

The contract for the water-works at Paris, Tex., has been awarded to M. K. Kelly, of Georgetown, for $70,000.

Messrs. Eischbach & McNeil, the contractors for the water-works at Gloucester City, N. J., have sued the city for $10,000 damages under their contract.

Bridge Contracts.—The contract for 250 tons of bolts for the Poughkeepsie bridge has been awarded to Messrs. Mitchell & Guylee.

The Wallis Iron Works Co., of Greenville, N. J., has been awarded the contract for a bridge over the Jersey Central R. R.

Messrs. Teague & Bennett, of Dover, Me., have been awarded the contract for a bridge across the York river for the new railroad from Kittery to York Beach.

The Berlin Bridge Co., of Berlin, Conn., has been awarded the contract for an iron bridge across the Quinebaug river at Quinebaug, Conn., for $7,892.

River Improvement.—The following proposals were opened December 29th, by Gen. Q. A. Gillmore at the Army Building, New York City, for improving the Savannah river below Augusta, Ga.: John F. Gaynor, Savannah, Ga., fascines, $1.27 per cubic yard; stone $2.57: total, $8,640, Albert J. Twiggs, Augusta, Ga., 75 cents, $3.50; total, $9,562.50. The work is to be commenced in 30 days and to be completed before June 30th, 1887.

The New Harlem Bridge.—It is rumored that the Union Bridge Co. is about to enter suit against the Harlem Bridge Commissioners. The charge is, that after signing a contract with the Union Bridge Co. for the total work, the Commissioners let it to another party for $277,093 in excess of their bid; and, further, that the Commissioners have never compensated the bridge company for their services in preparing plans, estimates, etc., upon which the present structure is being built.

Light Station.—The following proposals have been received by Major W. H. Heuer, U. S. Light-House Engineer, New Orleans, La., for rebuilding the Hone island light station, in Mississippi, (Eighth district): Wm. L. Camphile, Montgomery, Ala., $4,270; John H. Gardner, New Orleans, La., $5,469; Coombs & Co., Apalachicola, Fla., $5,875; Thomas G. Mackie, Algiers, La., $6,375.

Stone.—The following bids for furnishing and placing granite stone on the breakwater at Rockland, Me., have been received by Major Jared A. Smith, U. S. Engineer Office, Portland, Me.: John A. Hamilton & Rufus Soule, Chebeague, Me., 67 cents per ton; John F. Hamilton, Portland, Me., 67.9 cents; Joseph Fleurit & Alfred E. Hamilton, Chebeague, Me., 72 cents; Bodwell Granite Co., Rockland, Me., 74.5 cents; Wm. S. White, Rockland, Me., 76 cents; Chas. H. Edwards, Quincy, Mass., 94 cents; Sylvester & Bowe, Boston, Mass., 98.25 cents; Wm. F. Kittredge, Vinal Haven, Me., 97 cents; Wm. P. Hurley, Rockland, Me., 99.6 cents. The contract has been awarded to Hamilton & Soule.

Asphalt Paving.—At Columbus, O., the Warren-Scharf Asphalt Paving Co. has bid $1 per square yard for asphalt paving, and 15 cents per lineal foot for setting limestone curbing.

Street Work.—At Albany, N.Y., City Engineer and Surveyor Andrews has submitted his quantities for grading, filling, flagging, curbing and granite block pavement for next year. There will be a considerable amount of granite paving laid and other street work done.

At St. Paul, Minn., a considerable amount of street grading and improvement is to be done.

At Columbus, O., resolutions have been adopted for grading, curbing, paving, guttering, flagging, and brick sewers on a number of streets.

Bridge.—The following proposals have been received by the Bridge Committee, Nashville, Tenn., for the construction of the North Nashville bridge in Davidson county:

Substructure and Approaches.—Embankment of approach, John Broderick $9,620; Hicks & Holmes, $10,070. Foundations, John Broderick, $2,811.90; Hicks & Holmes, $2,713; Riley Bros. $2,597.75. Stone masonry, John Broderick, $15,100; Hicks & Holmes, $47,150. Riley Bros., $20,963. Combination brick and stone masonry, John Broderick $10,518.75; Hicks & Holmes $45,100.

Superstructure—King Iron Bridge & Manufacturing Co., Cleveland, O., iron, $26,800 and $26,500; combination, $21,000. Mount Vernon Bridge Co., iron, $27,152 and $26,200. Morse Bridge Co., Youngstown, O., iron $28,175; cantilever (iron), $27,340. W. H. Converse, Chattanooga Tenn., iron, $16,287; combination, $29,452. George H. Crafts, Atlanta, Ga., iron, $32,675 and $33,500; combination, $28,500. Columbia Bridge Co., Dayton, O., iron $31,750 and $33,200. Champion Bridge Co., iron, $36,000. Pennsylvania Bridge Co., iron, $38,900. Phœnix Bridge Co., iron, $39,830. Louisville Bridge & Iron Co., combination, $41,000.

Iron Foundations for Abutment No. 1 and Pier No. 2—The Iron Substructure Co., Columbus, O., $3,983.47.

Dredging.—The following proposals have been received by Major Jared A. Smith, U. S. Engineer Office, Portland, Me., for dredging in Portland harbor: National Dredging Co., Wilmington, Del., 13 cents per cubic yard in place; Moore & Wright, Portland, Me., 14.75 cents (10 cents in scow); New England Dredging Co., Boston, Mass., 17 cents; Geo. C. Forbes & Co., Baltimore, Md., 19 cents; Hamilton & Sawyer, Chebeague, Me., 24 cents; Thomas Symonds, Leominster, Mass., 31 cents; Frank Pidgeon Dredging Co., New York City, 36 cents in scow. The contract has been awarded to the National Dredging Co.

The following proposals have been recived by Lieut W. M. Black, U. S. Engineer Office, Jacksonville, Fla., for dredging in Apalachicola bay and the mouth of the Carabello river respectively: S. N. Kimball, 34.9 and 34.9 cents per cubic yard; John H. Gardiner, 35 and 45 cents; Rittenhouse Moore, 35.5 and 48.5 cents; Geo. C. Forbes & Co., 39 and 39 cents.

The following proposals were opened December 27th, at the Department of Docks, New York City, for dredging at several piers in the North river: Union Dredging Co., 20 cents per cubic yard; P. Sanford Ross, 21 cents; Wm. M. Tebo, 22 cents (informal); Atlantic Dredging Co., 24 cents.

Contractors Intelligence,

Engineering and Building Materials,

New York, December 30, 1886.

WHOLESALE PRICES.

IRON.

STRUCTURAL IRON.		
Angles	2.25c	@ 2.50c
" steel	2.40	@ 2.60
Tees	2.70	@ 2.90
Beams and channels, American	3.00	@
Tank plates	2.45	@ 2.60
Shell plates	2.70	@ 2.80
Steel plates, tank	2.90	@ 3.00
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black ..... Discount		37½
" " galvanized ..... "		27½
Lap welded, black ..... "		55
" galvanized ..... "		37½
Boiler tubes ..... "		45
RAILS.		
Steel (large lots at mill)	$36.00	@ $37.00
Old rails	24.00	@ 25.50
Old rails, steel	22.06	@ 23.00
S. R. spikes	2.25c	@ 2.40c
H. R. splice-plates	2.00	@ 2.10
R. R. track bolts, square nuts	2.85	@ 3.00
Barb-wire fencing, galvanized	3.85	@ 3.90
" " painted		4.00
Corrugated iron		
Nails		
Iron, per keg		2.15
Steel do.		2.30

METALS.

COPPER.		
Lake Superior	11.75	@
Other Brands	10.50	@ 11.00
LEAD.		
Com. Domestic	4.30	@ 4.35
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.70	@ 5.60

BRICK.

Cargoes (afloat)		
Choice Brands	8.50	
Haverstraw ..... per M.	7.75	@ 8 25
Fishkill	7.50	@ 7.75
Up-River	7.25	@ 7.50
Jerseys	7 00	@ 7.2
Long Island		
Pale	4.75	@ 5.00
FRONTS.		
Croton, red	13.00	@ 15.00
" dark	13.00	@ 15.00
" brown	12.00	@ 14.00
Philadelphia pressed	28.00	@ 29.00
Trenton "	27.00	@ 28.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	80.00	@ 120.00
Fire brick	25 00	@ 55.00
" American, No. 1	30.00	@ 35.00
" No. 2	25.00	@ 30.00

ASPHALT.

ROCK.		
French, per ton	$22 00	@ 25.00
German	15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.00

LIME.

Rocklock Cement Co.'s Ground	.80	
Rockland, common per bbl	1.00	
" finishing	1.20	
State, common	.85	@ .90
" finishing	1.05	@ 1.10
Kingston, ground	.90	
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.		
Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " " "		
Brown stone, Portland, Ct.	1.00	@ 1.35
" Belleville, N. J.	0.75	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
Base stone, from 2¼ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement	$1.20	@ 1.25
BAETJER & MEYERSTEIN:		
Hanover Port.and	$2.60	@ $2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25	@ 2.50
Fewen	2.25	@ 2.50
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40	@ 2.75
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50	@ 2.75
R. B. & S. "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer "	2.45	@ 2.75
Fleve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
EMIL LENZ, New York.		
Stettin Portland	2.35	@ 2.55
Fire-proof	1.75	@ 1.95
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
NEW YORK CEMENT Co.:		
Rosendale	1.20	@ 1.25
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale "Bridge" brand	1.20	@ 1.25
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S.	2 25	@ 2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25	@ 2.40
German "	2.00	@ 2.15
Standard	1.50	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand	1.00	@ 1.10

U. S. ENGINEER OFFICE,
WILMINGTON, N. C., DECEMBER 7th, 1886.

PROPOSALS for 2,000 tons Stone to be delivered at Beaufort Harbor, North Carolina, will be received at this office until noon January 8th, 1887, and opened immediately thereafter. Blank forms, specifications and information can be had upon application to this office.

W. H. BIXBY,
Captain of Engineers, U. S. A.

50-51 & Jan. 1.

U. S. ENGINEER OFFICE,
WILMINGTON, N. C., DECEMBER 7th, 1886.

PROPOSALS for furnishing about 800 tons coal and 200 cords wood for the improvement of Cape Fear River, North Carolina, will be received until noon January 8th, 1887, and opened immediately thereafter. Blank forms, specifications and information can be had upon application to this office.

W. H. BIXBY,
Captain of Engineers, U. S. A.

50-51 & Jan. 1.

U. S. ENGINEER OFFICE,
WILMINGTON, N. C., DECEMBER 7th, 1886.

PROPOSALS for hoisting engine to be delivered on the Neuse River at Kinston, North Carolina, will be received at this office until noon January 8th, 1887, and opened immediately thereafter. Blank forms, specifications and information can be had upon application to this office.

W. H. BIXBY,
Captain of Engineers, U. S. A.

50-51 & Jan. 1.

Proposals for Construction of Reservoir Outlet and Wing-Walls.

U. S. ENGINEER OFFICE,
2136 Pennsylvania Avenue, N. W.
WASHINGTON, D. C., December 14, 1886.

SEALED PROPOSALS, in triplicate, will be received at this office, until 12 M., on Monday, January 17, 1887, for the construction of the Reservoir Outlet and Wing-walls, in connection with the Reclamation of the Potomac Flats, at Washington, D. C. The structure will be of granite masonry, built on a foundation of piles, grillage and concrete; to be built within a coffer dam, in about six feet of water.

For detailed information, forms of bid, &c., apply to the undersigned.

PETER C. HAINS,
52—4t Lieut.-Col. of Engineers.

Improving James River, Va.

Proposals for Dredging and Rock Excavation; Construction of Mattress-Dykes; and Construction and Extension of Jetties.

U. S. ENGINEER OFFICE,
905½ EAST MAIN STREET,
RICHMOND, VA., December 24, 1886.

PROPOSALS for dredging and excavating rock from the channel of the James river, near Richmond, Va., for the construction of Mattress-Dykes, and for the construction and extension of Jetties, will be received until noon of January 26th, 1887, and opened immediately thereafter.

Blank forms, specifications and information can be had on application in person or by letter to the resident engineer, Mr. C. P. E. Burgwyn, 905½ East Main street, Richmond, Va.

WM. P. CRAIGHILL,
1-3t Lieut. Col. of Engineers, U. A. A.

Oberlin, Ohio, Water-Works.

Notice to Contractors.

SEALED PROPOSALS will be received by the Trustees of the Water-Works of the village of Oberlin, Ohio, at their office in said village, until 12 o'clock (noon) of Wednesday, January 26, 1887, for

(1.) The erection of pumping machinery having a daily capacity of two million gallons.

(2.) For the delivery of about five hundred tons of cast-iron pipe, and about ten tons of specials.

(3.) For the delivery of about fifty gates and seventy hydrants.

(4.) For laying said pipes and setting said gates and hydrants.

Specifications may be obtained at the office of the trustees.

Each proposal must be accompanied by a good and sufficient bond in the sum of two thousand dollars, as guarantee of good faith on the part of the bidder. Contractors will be required to give bonds for the faithful performance of the work.

The right to reject any or all bids is reserved.

EDWIN REGAL,
A. A. WRIGHT,
J. W. STEELE,
Trustees of Water-Works.

Dunham & Paine, Engineers,
1-1t. Cleveland, Ohio.

Dump Cars.

WANTED.—One Hundred Four Yard Standard Guage Dump Cars—second-hand.

J. F. SAXTON,
51-1t 52 Broadway, New York.